

University of Mumbai



No. AAMS_UGS/ICC/2022-23/ 109

CIRCULAR :-

Attention of the Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/44 of 2019-20 dated 9th July, 2019 relating to the revised syllabus of B.E.(Civil Engineering) (Sem. – VII & VIII) (CBCGS).

They are hereby informed that the recommendations made by the Board of Studies in Civil Engineering at its meeting held on 06th June, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 vide item No. 6.16 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 vide item No. 6.16 (R) and that in accordance therewith, the revised syllabus of B.E. (Civil Engineering) (Sem. – VII & VIII) (CBCS) Final Year (Rev-2019 'C' Scheme) has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
20th October, 2022

(Dr. Shailendra Deolankar)
I/c Registrar

To

The Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology.

A.C/6.16(R)/11/07/2022

No. AAMS_UGS/ICC/ 2022-23/ 109

20th October, 2022

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology,
- 2) The Chairman, Board of Studies in Civil Engineering,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Director, Department of Information & Communication Technology,
- 6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Desktop/Circular of Engineering/Priya

Copy to :-

1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),
2. The Deputy Registrar, College Affiliations & Development Department (CAD),
3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),
4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),
5. The Deputy Registrar, Executive Authorities Section (EA),
6. The Deputy Registrar, PRO, Fort, (Publications Section),
7. The Deputy Registrar (Special Cell),
8. The Deputy Registrar, Fort/Vidyanagari Administration Department (FAD) (VAD), Record Section,
10. The Professor-cum- Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. P.A. to Hon'ble Vice-Chancellor,
2. P.A. to Pro-Vice-Chancellor,
3. P.A. to Registrar,
4. All Deans of all Faculties,
5. P.A. to Finance & Account Officer, (F. & A.O.),
6. P.A. to Director, Board of Examination & Evaluation,
7. P.A. to Director, Innovation, Incubation and Linkages,
8. P.A. to Director, Board of Lifelong Learning and Extension (BLLE),
9. The Director, Dept. Of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,
10. The Director of Board of Student Development,
11. The Director, Department of Students Welfare (DSD),
12. All Deputy Registrar, Examination House,
13. The Deputy Registrars, Finance & Accounts Section,
14. The Assistant Registrar, Administrative sub-campus Thane,
15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,
16. The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri,
17. The Assistant Registrar, Constituent Colleges Unit,
18. BUCTU,
19. The Receptionist,
20. The Telephone Operator,
21. The Secretary MUASA,

for information.

University of Mumbai



**Revised Syllabus for
B.E. (Civil Engineering)
(Sem. - VII and VIII)
(Choice Based Credit System)**

(With effect from the academic year 2022-23)

University of Mumbai



O: _____	Title of Course	B.E. (Civil Engineering)
O: _____	Eligibility	After Passing Third Year Engineering as per the Ordinance 6244
R: _____	Passing Marks	40%
No. of years/Semesters:		4 years / 8 semesters
Level:		P.G. / U.G. / Diploma / Certificate
Pattern:		Yearly / Semester
Status:		New / Revised 2019
To be implemented from Academic Year :		With effect from Academic Year : 2022-23

Dr. Suresh K. Ukarande
Chairman,
Board of Studies in Civil
Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and
Technology University of
Mumbai

Dr Anuradha Majumdar
Dean,
Faculty of Science and
Technology University of
Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Final Year of Engineering from the Academic year 2022-23.

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill-based activities and project-based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Preface

The engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program Outcomes (POs) are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome-based education (OBE) in the process of curriculum development from Rev-2012 onwards and continued to enhance the curriculum further based on OBE in Rev-2016 and Rev-2019 "C" scheme.

As Chairman and Members of Board of Studies in Civil Engineering, University of Mumbai, we are happy to state here that, the Program Educational Objectives (PEOs) for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University, who are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The PEOs finalized for the undergraduate program in Civil Engineering are listed below;

1. To prepare the Learner with a sound foundation in mathematical, scientific and engineering

fundamentals

2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To prepare the Learner for a successful career in Indian and Multinational Organisations and for excelling in post-graduate studies
4. To motivate learners for life-long learning
5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process

In addition to the above listed PEOs, every institute is encouraged to add a few (2-3) more PEOs suiting their institute vision and mission

Apart from the PEOs, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of OBE. We strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Board of Studies in Civil Engineering University of Mumbai			
Dr. S. K. Ukarande	Chairman	Dr. V. Jothiprakash	Member
Dr. D.D. Sarode	Member	Dr. K. K. Sangle	Member
Dr. S. B. Charhate	Member	Dr. D. G. Regulawar	Member
Dr. Milind Waikar	Member	Dr. A. R. Kambekar	Member
Dr. R.B. Magar	Member	Dr. Seema Jagtap	Member

Semester – III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC301	Engineering Mathematics – III	03	-	01	03	-	01	04
CEC302	Mechanics of Solids	04	-	-	04	-	-	04
CEC303	Engineering Geology	03	-	-	03	-	-	03
CEC304	Architectural Planning & Design of Buildings	02	-	-	02	-	-	02
CEC305	Fluid Mechanics – I	03	-	-	03	-	-	03
CEL301	Mechanics of Solids	-	02	-	-	01	-	01
CEL302	Engineering Geology	-	02	-	-	01	-	01
CEL303	Architectural Planning & Design of Buildings	-	02	-	-	01	-	01
CEL304	Fluid Mechanics – I	-	02	-	-	01	-	01
CEL305	Skill Based Lab Course – I	-	03	-	-	1.5	-	1.5
CEM301	Mini Project – 1A	-	03 ^{\$}	-	-	1.5	-	1.5
Total		15	14	1	15	7	1	23

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test - I	Test – II	Avg.					
CEC301	Engineering Mathematics –III	20	20	20	80	03	25	-	125
CEC302	Mechanics of Solids	20	20	20	80	03	-	-	100
CEC303	Engineering Geology	20	20	20	80	03	-	-	100
CEC304	Architectural Planning & Design of Buildings	20	20	20	80	03	-	-	100
CEC305	Fluid Mechanics – I	20	20	20	80	03	-	-	100
CEL301	Mechanics of Solids	-	-	-	-	-	25	25	50
CEL302	Engineering Geology	-	-	-	-	-	25	25	50
CEL303	Architectural Planning & Design of Buildings	-	-	-	-	-	25	25	50
CEL304	Fluid Mechanics – I	-	-	-	-	-	25	25	50
CEL305	Skill Based Lab Course – I	-	-	-	-	-	50	-	50
CEM301	Mini Project – 1A	-	-	-	-	-	50	-	50
Total		100			400	-	225	100	825

\$ indicates work load of Learner (Not Faculty), for Mini Project.

Faculty Load: 1 hour per week per four groups.

Undergraduate Program Structure for Second year Civil Engineering

University of Mumbai

(With Effect from A.Y. 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC401	Engineering Mathematics – IV	03	-	01	03	-	01	04
CEC402	Structural Analysis	04	-	-	04	-	-	04
CEC403	Surveying	03	-	-	03	-	-	03
CEC404	Building Materials & Concrete Technology	03	-	-	03	-	-	03
CEC405	Fluid Mechanics-II	03	-	-	03	-	-	03
CEL401	Structural Analysis	-	02	-	-	01	-	01
CEL402	Surveying	-	03	-	-	1.5	-	1.5
CEL403	Building Material Concrete Technology	-	02	-	-	01	-	01
CEL404	Fluid Mechanics-II	-	02	-	-	01	-	01
CEL405	Skill Based lab Course – II	-	02	-	-	01	-	01
CEM401	Mini Project – 1B	-	03 ^{\$}	-	-	1.5	-	1.5
Total		16	14	01	16	07	01	24

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test - I	Test – II	Avg.					
CEC401	Engineering Mathematics-IV	20	20	20	80	03	25	-	125
CEC402	Structural Analysis	20	20	20	80	03	-	-	100
CEC403	Surveying	20	20	20	80	03	-	-	100
CEC404	Building Materials & Concrete Technology	20	20	20	80	03	-	-	100
CEC405	Fluid Mechanics-II	20	20	20	80	03	-	-	100
CEL401	Structural Analysis	-	-	-	-	-	25	25	50
CEL402	Surveying	-	-	-	-	-	50	25	75
CEL403	Building Material Concrete Technology	-	-	-	-	-	25	25	50
CEL404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL405	Skill Based lab Course - II	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1B	-	-	-	-	-	25	25	50
Total		100			400	-	225	125	850

\$ indicates work load of Learner (Not Faculty), for Mini Project.

Faculty Load: 1 hour per week per four groups.

Undergraduate Program Structure for Third year Civil Engineering

University of Mumbai

(With Effect from A.Y. 2021-2022)

Semester - V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theor y	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC501	Theory of Reinforced Concrete Structures	03	-	-	03	-	-	03
CEC502	Applied Hydraulics	03	-	-	03	-	-	03
CEC503	Geotechnical Engineering-I	03	-	-	03	-	-	03
CEC504	Transportation Engineering	04	-	-	04	-	-	04
CEDLO501X	Department Level Optional Course-1	03	-	-	03	-	-	03
CEL501	Theory of Reinforced Concrete Structures	-	02	-	-	01	-	01
CEL502	Applied Hydraulics	-	02	-	-	01	-	01
CEL503	Geotechnical Engineering-I	-	02	-	-	01	-	01
CEL504	Transportation Engineering	-	02	-	-	01	-	01
CEL505	Professional Communication and Ethics	-	02*+2	-	-	02	-	02
CEM501	Mini Project – 2A	-	04\$	-	-	02	-	02
Total		16	16	-	16	08	-	24

Examination Scheme

Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test - II	Avg.					
CEC501	Theory of Reinforced Concrete Structures	20	20	20	80	03	-	-	100
CEC502	Applied Hydraulics	20	20	20	80	03	-	-	100
CEC503	Geotechnical Engineering-I	20	20	20	80	03	-	-	100
CEC504	Transportation Engineering	20	20	20	80	03	-	-	100
CEDLO501X	Department Level Optional Course -1	20	20	20	80	03	-	-	100
CEL501	Theory of Reinforced Concrete Structures	-	-	-	-	-	25	25	50
CEL502	Applied Hydraulics	-	-	-	-	-	25	25	50
CEL503	Geotechnical Engineering-I	-	-	-	-	-	25	25	50
CEL504	Transportation Engineering	-	-	-	-	-	25	25	50
CEL505	Professional Communication and Ethics	-	-	-	-	-	25	25	50
CEM501	Mini Project – 2A	-	-	-	-	-	25	25	50
Total		100			400	-	150	150	800

* Theory class to be conducted for full class

\$ indicates work load of Learner (Not Faculty), for Mini Project.

Faculty Load: 1 hour per week per four groups.

Undergraduate Program Structure for Third year Civil Engineering

University of Mumbai

(With Effect from A.Y. 2021-2022)

Semester - V

Department Level Optional Course – 1

Sr. No.	Course Code CEDLO501X	Department Level Optional Course – 1
1	CEDLO5011	Modern Surveying Instruments and Techniques
2	CEDLO5012	Building Services & Repairs
3	CEDLO5013	Sustainable Building Materials
4	CEDLO5014	Advanced Structural Mechanics
5	CEDLO5015	Air and Noise Pollution & Control
6	CEDLO5016	Transportation Planning & Economics
7	CEDLO5017	Advanced Concrete Technology

Undergraduate Program Structure for Third year Civil Engineering

University of Mumbai

(With Effect from A.Y. 2021-2022)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC601	Design & Drawing of Steel Structures	03	-	-	03	-	-	03
CEC602	Water Resources Engineering	03	-	-	03	-	-	03
CEC603	Geotechnical Engineering-II	03	-	-	03	-	-	03
CEC604	Environmental Engineering	04	-	-	04	-	-	04
CEDLO601X	Department Level Optional Course -2	03	-	-	03	-	-	03
CEL601	Design & Drawing of Steel Structures	-	02	-	-	01	-	01
CEL602	Water Resources Engineering	-	02	-	-	01	-	01
CEL603	Geotechnical Engineering-II	-	02	-	-	01	-	01
CEL604	Environmental Engineering	-	02	-	-	01	-	01
CEL605	Skill Based Lab Course – III	-	03	-	-	1.5	-	1.5
CEM601	Mini Project – 2B	-	03 ^{\$}	-	-	1.5	-	1.5
Total		16	14	-	16	07	-	23

Examination Scheme

Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test – I	Test - II	Avg.					
CEC601	Design & Drawing of Steel Structures	20	20	20	80	04	-	-	100
CEC602	Water Resources Engineering	20	20	20	80	03	-	-	100
CEC603	Geotechnical Engineering-II	20	20	20	80	03	-	-	100
CEC604	Environmental Engineering	20	20	20	80	03	-	-	100
CEDLO601X	Department Level Optional Course -2	20	20	20	80	03	-	-	100
CEL601	Design & Drawing of Steel Structures	-	-	-	-	-	25	25	50
CEL602	Water Resources Engineering	-	-	-	-	-	25	25	50
CEL603	Geotechnical Engineering-II	-	-	-	-	-	25	25	50
CEL604	Environmental Engineering	-	-	-	-	-	25	25	50
CEL605	Skill Based Lab Course-III	-	-	-	-	-	25	25	50
CEM601	Mini Project – 2B	-	-	-	-	-	25	25	50
Total		100			400	-	150	150	800

\$ indicates work load of Learner (Not Faculty), for Mini Project

\$ indicates work load of Learner (Not Faculty), for Mini Project.

Faculty Load: 1 hour per week per four groups.

Undergraduate Program Structure for Third year Civil Engineering

University of Mumbai

(With Effect from A.Y. 2021-2022)

Semester - VI

Department Level Optional Course – 2

Sr. No.	Course Code CEDLO601X	Department Level Optional Course – 2
1	CEDLO6011	Rock Mechanics
2	CEDLO6012	Biological Processes & Contaminant Removal
3	CEDLO6013	Construction Equipment & Techniques
4	CEDLO6014	Urban Infrastructure Planning
5	CEDLO6015	Open Channel Flow
6	CEDLO6016	Computational Structural Analysis
7	CEDLO6017	Traffic Engineering and Management
8	CEDLO6018	Introduction to Offshore Engineering

Undergraduate Program Structure for Final year Civil Engineering

Semester VII & VIII
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)
Semester - VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC701	Design & Drawing of Reinforced Concrete Structures	03	-	-	03	-	-	03

CEC702	Quantity Survey, Estimation and Valuation	03	-	-	03	-	-	03
CEDLO701X	Department Level Optional Course – 3	03	-	-	03	-	-	03
CEDLO702X	Department Level Optional Course – 4	03	-	-	03	-	-	03
CEILO701X	Institute Level Optional Course – I	03	-	-	03	-	-	03
CEL701	Design & Drawing of Reinforced Concrete Structures	-	02	-	-	01	-	01
CEL702	Quantity Survey, Estimation and Valuation	-	02	-	-	01	-	01
CEP701	Major Project-Part I	-	06*	-	-	03	-	03
Total		15	10	-	15	05	-	20

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC701	Design & Drawing of Reinforced Concrete Structure	20	20	20	80	04	-	-	100
CEC702	Quantity Survey, Estimation and Valuation	20	20	20	80	04	-	-	100
CEDLO701X	Department Level Optional Course – 3	20	20	20	80	03	-	-	100
CEDLO702X	Department Level Optional Course – 4	20	20	20	80	03	-	-	100
CEILO701X	Institute Level Optional Course – I	20	20	20	80	03	-	-	100
CEL701	Design & Drawing of Reinforced Concrete Structure	-	-	-	-	-	25	25	50
CEL702	Quantity Survey, Estimation and Valuation	-	-	-	-	-	25	25	50
CEP701	Major Project-Part I	-	-	-	-	-	25	25	50
Total		100			400	-	75	75	650

*** Faculty load- In Semester VII - 1/2 hour per week per project group**

Undergraduate Program Structure for Final year Civil Engineering

University of Mumbai

(With Effect from A.Y. 2022-2023)

Semester - VII

Department Level Optional Course – 3

Sr. No.	Course Code CEDLO701X	Department Level Optional Course – 3
1	CEDLO7011	Pre-stressed Concrete
2	CEDLO7012	Applied Hydrology and Flood Control
3	CEDLO7013	Appraisal and Implementation of Infra Projects

4	CEDLO7014	Analysis of Offshore Structures
5	CEDLO7015	Advanced Construction Technology
6	CEDLO7016	Pavement Materials Construction and Maintenance

Department Level Optional Course – 4

Sr. No.	Course Code CEDLO702X	Department Level Optional Course – 4
1	CEDLO7021	Foundation Analysis and Design
2	CEDLO7022	Solid and Hazardous Waste Management
3	CEDLO7023	Ground Improvement techniques
4	CEDLO7024	Green building constructions
5	CEDLO7025	Legal Aspects in constructions
6	CEDLO7026	Environmental impact assessment
7	CEDLO7027	Advanced Design of Steel Structures

Institute Level Optional Course – I

Sr. No.	Course Code CEILO701X	Institute Level Optional Course – I
1	ILO7011	Product Life-cycle Management
2	ILO7012	Reliability Engineering
3	ILO7013	Management Information Systems
4	ILO7014	Design of Experiments
5	ILO7015	Operations Research
6	ILO7016	Cyber Security and Laws
7	ILO7017	Disaster Management and Mitigation Measures
8	ILO7018	Energy Audit and Management
9	ILO7019	Development Engineering

Undergraduate Program Structure for Final year Civil Engineering

University of Mumbai

(With Effect from A.Y. 2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC801	Construction Management	03	-	-	03	-	-	03
CEDLO801X	Department Level Optional Course – 5	03	-	-	03	-	-	03
CEDLO802X	Department Level Optional Course – 6	03	-	-	03	-	-	03
CEILO801X	Institute Level Optional	03	-	-	03	-	-	03

	Course – II							
CEL801	Construction Management	-	02	-	-	01	-	01
CEP801	Major Project – Part II	-	12 ^{\$}	-	-	06	-	06
Total		12	14	-	12	07	-	19

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test - I	Test – II	Avg.					
CEC801	Construction Management	20	20	20	80	03	-	-	100
CEDLO801X	Department Level Optional Course – 5	20	20	20	80	03	-	-	100
CEDLO802X	Department Level Optional Course – 6	20	20	20	80	03	-	-	100
CEILO801X	Institute Level Optional Course – II	20	20	20	80	03	-	-	100
CEL801	Construction Management	-	-	-	-	-	25	25	50
CEP801	Major Project – Part II	-	-	-	-	-	50	100	150
Total		80			320	-	75	125	600

\$: Faculty load- In Semester VIII - 1 hour per week per project group

Undergraduate Program Structure for Final year Civil Engineering University of Mumbai

(With Effect from A.Y. 2022-2023)

Semester VIII

Department Level Optional Course – 5

Sr. No.	Course Code CEDLO801X	Department Level Optional Course – 5
1	CEDLO8011	Bridge Engineering
2	CEDLO8012	Design of Hydraulic Structures
4	CEDLO8013	Construction Safety
5	CEDLO8014	Pavement Design
6	CEDLO8015	Industrial Waste Treatment
7	CEDLO8016	Soil Dynamics

Department Level Optional Course – 6

Sr. No.	Course Code CEDLO802X	Department Level Optional Course – 6
1	CEDLO8021	Repairs, Rehabilitation and Retrofitting of structures
2	CEDLO8022	Physico-Chemical Treatment of Water and Waste Water
3	CEDLO8023	Transportation System Engineering
4	CEDLO8024	Smart Building Materials
5	CEDLO8025	Structural Dynamics
6	CEDLO8026	Ground Water Engineering

Institute Level Optional Course – II

Sr. No.	Course Code CEILO801X	Institute Level Optional Course – II
1	ILO8011	Project Management
2	ILO8012	Finance Management
3	ILO8013	Entrepreneurship Development and Management
4	ILO8014	Human Resources Management
5	ILO8015	Professional Ethics and Corporate Social Responsibility (CSR)
6	ILO8016	Research Methodology
7	ILO8017	Intellectual Property Rights and Patenting
8	ILO8018	Digital Business Management
9	ILO8019	Environmental Management

Faculty may design and conduct practicals for elective subjects wherever possible, under the head ‘content beyond syllabus’.

Semester VII

Semester VII

Course Code	Course Name	Credits
CEC701	Design and Drawing of Reinforced Concrete Structures	3

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
3	--	--	3	--	--	3

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	04 Hrs.	--	--	--	100

Rationale

Reinforced concrete construction is widely used for residential, commercial and industrial structures. IS code has specified the use of Limit State Method (LSM) design philosophy for design of structures. During previous semester students have studied design of basic elements by LSM. This course covers complete design of G+3 RCC framed building in addition to other structures like water tank and retaining wall. Prestressed Concrete structures are another class of structures used for bridge girders, long span slabs etc. Civil Engineers must have knowledge of designing and detailing of RCC and PSC structures to make structures safe and serviceable during its life span. The knowledge about response of structures during an earthquake is prerequisite for Civil Engineers. The course introduces Prestressed concrete and Earthquake Resistant Design of structures with drawing and detailing as per IS Code specifications.

Objectives

1. To explain the LSM design procedure of G+3 RCC framed building by application of IS code clauses including loading calculations, analysis and design of individual elements with detailing of reinforcements.
2. To explain the concepts in the design of water tanks.
3. To explain the concepts in the design of retaining walls.
4. To introduce the basics of structural dynamics, structural behavior under the dynamic load and the effect of damping.
5. To introduce earthquake resistant design approach.
6. To develop the practice of design using charts and tables from SP:16 published by BIS.
7. To introduce concept of Pre-stressed Concrete.

Detailed Syllabus

Module	Contents		Periods
I	Comprehensive Design of Building		11
	1.1	Analysis and design of residential/commercial/industrial (G+ 3) RCC framed building.	
	1.2	Load transfer mechanism, arrangement of beams, slabs and columns.	
	1.3	Design of Staircase (Dog legged and Open well type), Slabs (One way and Two way with continuity), Beams (Simply supported, Cantilever, Continuous), Columns (Axially loaded and Eccentrically loaded), Footings (Isolated and Combined).	
II	Design of Retaining Wall		06
	2.1	Design of Cantilever retaining wall	
	2.2	Design of Counterfort retaining wall	
III	Design of Water Tank		07
	3.1	Classification of Water Tank, Permissible Stresses, and Design of circular and rectangular water tanks resting on ground and underground. Codal provisions as per IS 3370:2020. Use of IS coefficient method and approximate method.	
	3.2	Introduction to design of elevated water tank, frame and shaft type of staging.	
IV	Introduction to Structural Dynamics		06
	4.1	Definition of basic terms used in structural dynamics. Static and dynamic loads, types of dynamic load.	
	4.2	Introduction to single degree of freedom system (SDOF), evaluation of dynamics response of SDOF system. Approximate method for determination of time period of vibration.	
V	Earthquake Resistant Design of Structures		06
	5.1	Earthquake motion and response of structure.	
	5.2	Design load calculation by seismic coefficient method.	
	5.3	Ductile design and detailing as per IS: 13920.	
VI	Introduction to Pre-stressed Concrete		03
	6.1	Prestressed Concrete: basic principles of prestressed concrete, materials used, systems of prestressing.	
	6.2	Losses in prestress.	
Total			39
Contribution to Outcome			

On completion of this course, the students will be able to:

1. Design G+3 RCC framed building using IS code recommendations.
2. Design different types of retaining walls with detailing of reinforcement
3. Design different types of water tanks with detailing of reinforcement.
4. Apply the basic concepts of structural dynamics

5. Evaluate the response of structure during an earthquake and calculate design forces.
6. Explain principles of Pre-stressed Concrete and its losses.

Internal Assessment

20 Marks

Consisting of two class tests - first test based on approximately 40% of content and second test based on remaining content (approximately 40% but excluding content covered in first test). Average of marks will be considered for IA.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. **Use of relevant IS codes shall be allowed in the examination.**
2. Question paper will comprise of total six questions, each carrying 20 marks.
3. Question 1 will be compulsory based on entire syllabus.
4. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
5. Four questions need to be solved in total.

Recommended Books:

1. Design of Reinforced Concrete Structures: *Dayaratnam, P*; Oxford and IBH.
2. Reinforced Concrete - Limit State Design: Ashok K. Jain, Nemchand & bro.
3. Limit State Design of Reinforced Concrete: Shah and Karve, Structure Publications, Pune.
4. Design of Prestressed Concrete Structures: Lin T.Y. and Ned Burns; John Wiley.
5. Reinforced Concrete: H.J. Shah, Charotar Publishers, Anand.
6. Prestressed concrete : Krishna Raju, Tata Mc-Graw Hill Publishing House, New Delhi
7. Illustrated Reinforced Concrete Design: Dr. V. L. Shah and Dr. S. R. Karve, Structure Publications, Pune.
8. Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A, John Wiley (2007), 7th Edition.
9. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.
10. Earthquake resistant design of structures: Pankaj Agarwal, Manish Shrikhande, PHI, New Delhi.

Reference Books:

1. Design of RCC structural Elements (RCC Vol-I): Bhavikatti, S. S., New Age International Publications.
2. Reinforced Concrete: Syal and Goel, Wheeler Publishers.
3. Reinforced Concrete Design: Pillai, S.U. and Menon Devdas, Tata Mc-Graw Hill Publishing House, New Delhi.

4. Reinforced Concrete Design by S.N. Sinha, Tata Mc-Graw Hill Publishing House, New Delhi.
5. Theory of Reinforced concrete structures by N. Subramanian, Oxford University Press.
6. Pre-stressed concrete: N. Rajgopalan, Narosa Publishers.
7. Relevant IS Codes: BIS Publications, New Delhi.

Semester VII		
Course Code	Course Name	Credits
CEC702	Quantity Survey, Estimation & Valuation	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	04 Hrs.	--	--	--	100

Rationale

Any structure, i.e., building, bridge, dam etc. consists of various building materials. Due to rise in the cost of materials, the structure has to be designed so that it is safe, serviceable and economical. Without proper design and estimation, it may lead to the increase in cost of construction and it further affects the economical aspect of the structure. A prior knowledge of various building materials is required for the construction and it controls the cost of the structure, save wastage of labor-hours and eventually helps in giving the correct amount required and quantity of various materials required. It also helps in scheduling of men, materials and machine to be used in the project at stages. The scope of the subject includes estimating, costing, analysis of rates, specification, valuation, tender and contracts etc.

Objectives

1. To emphasize the importance of relevant IS: 1200 - 1964 codes and understand Measurement systems for various items of civil engineering structures
2. To draft the specifications for various items of work & determine unit rates of items of works & to prepare the rate analysis for various items of work using DSR for reference.
3. To study the various methods of detailed and approximate estimates.
4. To calculate the quantity of earthwork using various methods.
5. To study the process of tendering and its various stages, various types of contracts, its suitability and validity as per the Indian Contract Act of 1872 and draft various clauses and conditions of a contract.
6. To explain the concept of valuation & to determine the present fair value of any constructed building at stated time.

Detailed Syllabus			
Module	Sub-Modules/ Contents		Hrs.
I.	Introduction		03
	1.1	Importance of Course	
	1.2	Measurement systems for specific items of civil engineering structures	
	1.3	Units of measurement of various items of works	
	1.4	IS1200: - Introduction, deduction rules for Masonry & Plastering work	
II.	Specifications & Rate Analysis		06
	2.1	Types & importance of specifications, rules to be followed for drafting the specifications of important items of work etc.	
	2.2	Rate analysis, its importance & necessity, Factors affecting rate analysis, Task work, sources of materials, Study of IS 7272 regarding labor output, District Schedule of Rates (DSR) Rate analysis of important items of construction works.	
	Estimates		

III.	3.1	Approximate Estimate Definition & Purposes of approximate estimates, Methods for preparing approximate estimates & numerical based on methods, Various terms such as administrative approval, technical sanction, Contingencies, Work charged establishments etc.	12
	3.2	Detailed Estimate Definition & purposes of detailed estimate, Data required for preparation of detailed estimate. Introduction of detailed estimate of load bearing structure. Methods of taking out quantities such as long wall & short wall method, Centre line method for R.C.C. framed structure, Bar Bending Schedule & its necessity, preparation of bar bending schedule of various structural elements as per code IS2502.	
IV.	Estimation of Earthwork for Roads & Canals		04
	4.1	Methods of computation of volume of earthwork such as mean area method, mid-sectional area method, Prismoidal formula, Trapezoidal formula etc. & numerical based on methods. Introduction of Mass Haul diagram, Terms like lead & lift etc.	
V.	Tenders & Contracts		06
	5.1	Tenders Definition & types of tenders, Tender notice & its inclusions, Pre-qualification of contractors, Pre-bid meeting, Procedure for submission & opening of tender, acceptance & rejection of tender, Tender validity period, E-Tendering	
	5.2	Contracts Definition, basic forms such as Valid, void & voidable contract. General types of contracts with their suitability, conditions of contract	

VI.	Valuation		08
	6.1	Difference between cost, price & value. Types of value, Valuation & its purposes. Various terms such as depreciation, sinking fund, capitalized value, years purchase etc. Methods for calculating depreciation of building such as Straight-line method, Sinking fund method Freehold Properties, Leasehold Properties, Easement rights	
	6.2	Methods of valuation such as Rental method, land & building method, Belting method etc. Numerical based on valuation	

Contribution to Outcomes

On completion of the course, the learners will be able to:

1. **Apply** the measurement systems to various civil engineering items of work.
2. **Draft** the specifications for various items of work & determine unit rates of items of works
3. **Estimate** approximate cost of the structures by using various methods & **prepare** detailed estimates of various civil engineering structures, including bar bending schedule, by referring drawings.
4. **Assess** the quantities of earthwork & **construct** mass haul diagrams.
5. **Draft** tender notice & **demonstrate** the significance of the tender as well as contract process.
6. **Determine** the present fair value of any constructed building at stated time.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests – First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test). Average of marks will be considered for IA.

End Semester Examination:

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1) Question paper will comprise of **six** questions; each carrying 20 marks.
- 2) The **first** question will be **compulsory** based on computation of quantities of various items of work by referring drawings.
- 3) The remaining **five** questions will be based on all the modules of entire syllabus. For this, the modules shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.
- 4) The students will have to attempt any **three** questions out of remaining five questions.

Total **four** questions need to be attempted.

- 5) There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics / sub-topics.

Recommended Books:

- 1) Estimating, Costing, Specifications and Valuation: *Chakraborty, M.*, Kolkata.
- 2) Building and Engineering Contracts: *Patil, B. S.*, University Press, Hyderabad.
- 3) Estimating and costing: *Datta, B. N.*, UBS Publications
- 4) Relevant Indian Standard Specifications, BIS Publications
- 5) Professional Practice: Dr. Roshan H. Namavati
- 6) World Bank approved contract documents

Semester VII

Course Code	Course Name	Credits
CEDLO7011	Department Level Optional Course-3: Pre-stressed Concrete	3

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
3	--	--	3	--	--	3

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs	--	--	--	100

Rationale

The course is aimed to make the learners aware about highly mechanized technology in civil engineering construction and to develop the basic understanding of prestressed concrete which is used in a wide range of civil structures like high rise buildings, residential slabs and bridges etc. Prestressed Concrete improves performance/efficiency of the section. It reduces cross sectional dimensions that results in material saving when compared with simple reinforced concrete sections.

Objectives

- 1 To make the learner to understand difference between PSC and RCC section in terms of material and method / technique used for construction.
- 2 To make the learner to understand the principle of prestressing, analysis of prestressed concrete sections and losses in prestress.
- 3 To make the candidate able to understand and implement the guidelines of Indian Standard code for analysis and design sections using limit state philosophy.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Introduction of Pre-stressed Concrete		02
	1.1	Basic concept and general principle	
	1.2	Materials used and their properties, need of high strength concrete and steel	
	1.3	Techniques and systems of prestressing	
	1.4	Advantages of Prestressed Concrete	
II	Analysis of Pre-stressed Concrete Beams		10
	2.1	Loading stages, permissible stresses in concrete in compression and tension at transfer and service stages as per limit state of serviceability, maximum compression and limit state of serviceability cracking, permissible stresses in steel, stress method of analysis	

	2.2	Load balancing method of analysis, cable profile	
	2.3	Kern points, pressure line, efficiency of section, internal resisting couple method of analysis,	
III	Losses in Prestress		06
	3.1	Loss of stresses in steel due to elastic deformation of concrete, creep in concrete, shrinkage in concrete, relaxation in steel, anchorage slip and friction	
IV	Analysis of Pre-stressed Concrete Beams in Limit State of Serviceability Deflection		04
	4.1	Deflection at transfer, short time and longtime deflection of uncracked beams, permissible limits	
V	Analysis and Design of Pre-stressed Concrete Beams in Limit State of Collapse		10
	5.1	Shear - Principal tension, permissible limit, analysis and design of beams in shear (sections uncracked in flexure)	
	5.2	Flexure - General philosophy of design, assumptions, analysis and design of beams in flexure	
VI	Design of Pre-stressed Concrete Beams in Limit State of Serviceability, Maximum Compression and Cracking		07
	6.1	Suitability of section modulus	
	6.2	Optimum pre-stressing force and corresponding eccentricity	
	6.3	Safe cable zone	

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Explain the concept of pre-stressing, its casting techniques and applications.
- 2 Describe difference between RCC and PSC elements and their behavior.
- 3 Estimate the loss of stresses in pre-stressing steel.
- 4 Analyze and design the pre-stressed concrete element using relevant IS Code.

Site Visit:

The learners shall visit a construction site of pre-stressed concrete and submit a report.

Internal Assessment

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of marks will be considered for IA.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.

- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books/Code:

- 1 Prestressed Concrete: *N. Krishna Raju*, Tata McGraw-Hill Publishing Company Limited, New Delhi
- 2 Fundamentals of Prestressed Concrete: *N.C Sinha* and *S.K. Roy*, S. Chand Publishing
- 3 Prestressed Concrete: *N. Rajagopalan*, Narosa Publishing House
- 4 Prestressed Concrete Structures: *P. Dayaratnam*, Oxford and IBH Publishing Co. Pvt. Ltd.
- 5 Prestressed Concrete: *S. Ramamrutham*, Dhanpat Rai Publishing Company Pvt. Ltd, New Delhi
- 6 IS code: IS:1343-2012

Reference Books:

- 1 Design of Prestressed Concrete Structures: *T. Y. Lin* and *N.H. Burns*, Wiley India Pvt. Ltd.
- 2 Design of Prestressed Concrete: *Arthur H. Nilson*, Wiley

Semester VII						

Course Code	Course Name					Credits
CEDLO7012	Department Level Optional Course-3: Applied Hydrology & Flood Control					03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
3	--	--	3	--	--	3

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 hrs	-	-	-	100

Rationale

This course deals with the various processes involved in hydrological cycle and provides in depth understanding of the theories and concepts of surface, subsurface and ground water hydrology. It focuses on types and forms of precipitations. It also explains the application of hydrographs, unit hydrographs and further describes various techniques of estimating stream flows. It further describes the various techniques of estimating streamline flows. It also describes the importance of floods, flood routing and ground water hydrology.

Objectives

1. To explain the various processes involved in the hydrological cycle.
2. To measure rainfall, computation of average rainfall, various water losses etc.
3. To differentiate the various stream flow measurement and its importance.
4. To interpret the hydrograph and unit hydrographs, applications of unit hydrograph concept.
5. To evaluate various flood control methods, estimate design flood, and flood routing
6. To describe the concepts of ground water movement, steady and unsteady flow towards fullypenetrating wells and well yields.

Detailed Syllabus

Module	Sub-Modules/ contents	Periods
I	1.1 Introduction: Hydrological cycle, scope of hydrology, water budget equation, data sources.	8
	1.2 Precipitation: Measurement of precipitation, network of rain gauges and their adequacy in a catchment, methods of computing average rainfall, hyetograph and mass curve of rainfall, adjustment of missing data, station year method and double mass curve analysis, Depth-Area -Duration relationship, Intensity-Duration - Frequency	

	relationship, Probable Maximum Precipitation.	
II	2.1 Abstractions from Precipitation: Evaporation and transpiration, evapo-transpiration, interception, depression storage, infiltration and infiltration indices, determination of water losses.	6
	2.2 Stream Flow Measurement: Measurement stream-flow by direct and indirect methods, measurement of stage and velocity, area-velocity method, stage-discharge relationships, current meter method, pitot tube method, slope-area method, rating curve method, dilution technique, electro-magnetic method, ultrasonic method.	
III	3.1 Runoff: Catchment, watershed and drainage basins, Factors affecting runoff, rainfall-runoff relationship, runoff estimation, droughts	6
IV	4.1 Hydrograph Analysis: Characteristics, base flow separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, Instantaneous unit hydrograph.	7
V	5.1 Floods: Estimation, envelope curves, flood frequency studies, probability and stochastic methods, estimation of design flood, flood control methods, Limitations, risk-reliability and safety factor. Flood routing: Hydrologic and hydraulic routings.	6
VI	6.1 Ground Water Hydrology: Yield, transmissibility, Darcy's law, Dupuit's theory of unconfined flow, steady flow towards fully penetrating wells (confined and unconfined). Unsteady flow towards wells: Jacob's curve and other methods, use of well Function, pumping tests for aquifer characteristics, methods of recharge.	6
Total		39

Contribution to Outcomes

On completion of the course, the learners will be able to:

1. Explain hydrologic cycle and various methods of Measurement of rainfall.
2. Calculate optimum number of rain gauge stations for average rainfall and missing rainfall over catchment
3. Describe various methods of measurement of stream flow and to calculate abstraction losses over the catchment
4. Develop rainfall runoff relationship and calculating runoff over catchment
5. Perform hydrologic and hydraulic routing
6. Calculate the discharge of well for confined and unconfined aquifer

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests – First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test). Average of marks will be considered for IA

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only four questions need to be solved in total

Recommended books:

1. Irrigation Engineering and Hydraulic Structures: S.K. Ukarande, Ane Books Pvt. Ltd. ISBN-978-93-83656-89-9
2. Irrigation and Water Power Engineering: B.C. Punmia, Pande B.B.Lal, A.K Jain. Laxmi Publications Pvt, Ltd. New Delhi

3. Irrigation Water Resources and Water Power Engineering: P.N. Modi, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
4. Irrigation Engineering and Hydraulics Structures: S. K. Garg, Khanna Publishers. Delhi.
5. Engineering Hydrology: *K. Subramanya*, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
6. Hydrology: *H. M. Raghunath*, New Age International Publishers, New Delhi
7. Elementary Hydrology: *V. P. Singh*, Prentice Hall
8. Engineering Hydrology: Principles and practice: *V. M. Ponce*, Prentice Hall

Semester VII		
Course Code	Name of the Course	Credits
CEDLO7013	Department Level Optional Course 3: Appraisal & Implementation of Infrastructure Projects	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					TW/ Pract/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	-	-	-	100

Rationale

For any Civil Engineering project, a range of alternative schemes meeting project goals are feasible. Thus to identify the most suitable out of it, project evaluation has to be carried out in terms of financial viability, environmental impact, utility to the society, engineering feasibility, profitability, etc. This course is intended to make students aware of this evaluation (appraisal) criterion for any Civil engineering project. Students will understand the importance of feasibility studies and get acquainted to the process of preparing a project report, both being crucial role players while deciding the viability of a project. The professional construction engineering practice will be rendered meaningful if students learn about ways to raise project funds, their effective planning and optimum utilisation. This course is devised to help students in understanding financial and economic aspects of a project.

Objectives

1. To know the procedure of feasibility studies for any infrastructure project.
2. To learn the procedure of appraisals required for deciding the worthiness of any project.
3. To learn the procedure of forecasting demand and know the uncertainties involved.
4. To know the components and importance of technical & managerial appraisal.
5. To get acquainted with decision making tools like Break even analysis, SWOT analysis etc.
6. To get acquainted with different methods of project finance and implementation.

Detailed Syllabus			
Module	Sub-Modules/ Contents		Hrs
I.	Construction Projects and Report Preparation		03
	1.1	Classification of construction projects. Project Formulation and phases involved in it.	
	1.2	Feasibility studies, SWOT analysis. Preparation of Project report.	
II.	Project Appraisal		06
	2.1	Importance and phases in a project development cycle for major infrastructure projects.	
	2.2	Importance of Appraisal, its need and steps involved in it.	
III.	Market Appraisal		09
	3.1	Importance and methods of carrying out demand analysis. Sources to gather project related information and ways to carry out market survey.	
	3.2	Methods to forecast demands. Uncertainties involved in demand forecasting.	
IV.	Technical and Managerial Appraisal		06
	4.1	Method to study the technical appraisal/viability of a project in terms of its location, type of land and intended use of building, technology requirements of the project, Size and complexity of tools and plants, raw materials to be used and their impact on the vicinity, energy requirements, water supply and disposal of effluents if any.	
	4.2	Study of managerial requirements of a project, Desirable organisational structure and hierarchy to manage as well as implement the project, Method of assessment of entrepreneurs.	
V.	Financial analysis and Economic Appraisal		09
	5.1	Various costs related to a project, Methods to determine the profitability of a project, Break even analysis.	
	5.2	Economic appraisal: Urgency, Payback period, Avg. Rate of return, Net Present Value, Internal rate of return, Benefit cost ratio, Cost of Capital etc.	
VI.	Project Financing and Implementation		06
	6.1	Types and Sources of finance in local, National and International context. Issues related to project financing.	
	6.2	Agencies involved in the implementation of a project. Methods of implementation like Built, operate and Transfer and its other variants like B.O.O, B.O.O.T, B.L.T, EPC ,etc.	
Total			39

Contribution to Outcomes

On successful completion of the course, the learners will be able to:

- 1) **classify** the projects and **describe** the phases involved in project formulation.
- 2) **prepare** a detailed project report on the basis of various feasibility studies and SWOT analysis.
- 3) **devise** a project's development cycle and get acquainted with the different appraisals in the process of deciding the worthiness of a project.
- 4) **exhibit** and **apply** the managerial skills and knowledge of financial aspects required during the implementation of projects.
- 5) **identify** various sources for project finance.
- 6) **know** the various agencies involved in project implementation as well as **select** the method of project implementation which is best suited for a particular project.

Theory Examination:

- Question paper will comprise of **six** questions; each carrying 20 marks.
- The **first** question will be **compulsory** which will have the short questions having weightage of 4-5 marks covering the entire syllabus.
- The remaining **five** questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module or contents thereof.
- There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any **three** questions out of remaining five questions.
- Total **four** questions need to be attempted.

Recommended Books:

- 1) Project Preparation, Appraisal, Budgeting, and Implementation: Prasanna Chandra (Tata McGraw Hill).
- 2) Infrastructure Development & Financing in India - N. Mani (New Century Publications).
- 3) Infrastructure & economic development - Anu Kapil (Deep & Deep Publications).
- 4) Construction Management: Planning and finance - Cormican D. (Construction press, London).
- 5) Engineering Economics – Kumar (Wiley, India).
- 6) Real Estate, Finance and investment - Bruggeman. Fishr (McGraw Hill).
- 7) The cost management toolbox; A Managers guide to controlling costs and boosting profits. - Oliver, Lianabel (Tata McGraw Hill).

Semester- VII

Course Code	Course Name	Credits
CEDLO 7014	Department Level Optional Course 3: Analysis of Offshore Structures	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	--	--	--	100

Rationale

Offshore Engineering discipline deals with the design and construction of structures intended to work in the ocean environment. The majority of offshore structures are used in the Oil and Gas industry. Offshore construction is the installation of structures and facilities in a marine environment. Civil Engineering graduates will be able to study analysis and design in the specialized field of ocean and coastal environment.

Objectives

The objectives of this course are

1. to explain the types and materials used in offshore structures.
2. to provide an understanding of the structural response of offshore structures based on both component and system
3. to address the general engineering analysis and design concepts of offshore structures

Detailed Syllabus		
Module	Course Modules / Contents	Hrs.
I	Types of offshore structures	05
	Types of offshore structures, planning and design aspects, Overview of functional, environmental and accidental loads for marine structures, with emphasis on wind - and wave induced loads.	
II	Materials and their behaviour	06
	Hydrodynamic interaction, Effects and dynamic response, Materials and their behaviour under static and dynamic loads, allowable stresses, various design methods and codes, design consideration, design loads.	
III	Analysis of offshore structures	06
	Basics of Hydrodynamics, Structural dynamics, Advanced structural analysis techniques, Statistics of extremes: Airy Wave Theory, Higher order wave theories, Irregular Sea States, Short and long term statistics of wind; static wind load, Aerodynamic admittance function and gust factor.	
IV	Estimation of wave forces	06
	The Morison's equation, wave force, lift force on members, wave slam, maximum force and moments using linear theory, Vertical Piles, Horizontal Bracings, Diagonal Front Face Bracings, Diagonal Side Face Bracings, wave forces on large diameter members, Froude-Krylov Theory, Diffraction Theory, Drift force, Spectral and statistical analysis of wave forces.	
V	Vibrations	10
	Mass-spring system, Free Vibrations with Damping, Forced Vibrations, Forced Damped Vibrations, Torsional Vibrations, Elements of single d.o.f. system, Dynamics of multi d.o.f. systems, Eigen values and vectors; Iterative and transformation methods; Mode superposition, Fourier series and spectral method of response of single d.o.f. systems, Vibration of bars, beams, Behavior of concrete gravity platform as a rigid body on soil as a continuum	
VI	Corrosion and allowances	06
	Corrosion and other allowances, consideration of stress concentration, Ingredient materials and protective measure, Behavior of concrete gravity platform as a rigid body on soil as a continuum	
Total		39

Contribution to Outcome

Upon completion of the course, students shall have ability to:

1. Explain the types and materials used in offshore structures
2. Evaluate of the structural response of offshore structures based on both component and system.
3. Apply general engineering and design concepts to offshore structures
4. Apply Morison's equations to calculate wave force, lift force, etc.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests:**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of marks will be considered for IAE

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

Recommended Books:

1. Subrata K. Chakrabarti (2005): Handbook of offshore engineering Volume-I & II, Elsevier, The Boulevard Langford Lane, Kidlington, Oxford OX5 1GB, UK.
2. Deo M C (2013): Waves and Structures, <http://www.civil.iitb.ac.in/~mcdeo/waves.html>
3. American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Load and Resistance Factor Design, 1st Edition, 1993. (TP690.A642 RP2A-LRFD)
4. American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design, 21st ed., 2000. (TP690.A642 RP2A-WSD).
5. Brebbia C.A. and Walker, "Dynamic Analysis of offshore structures", Newness butterworth, London, 1978.
6. Sarpakaya T. and Isaacson M., "Mechanics of Wave Forces on Offshore Structures", Van Nostrand Reinhold, New York, 1981.

7. Hallam M.G., Heaf N.J. and Wootton, L.R., "Dynamics of Marine Structures", CIRIA Publications, Underwater Engg. Group, London, 1978.
8. Graff W.J., "Introduction to Offshore Structures", Gulf Publishing Co., Houston, Texas, 1981.
9. Clough R.W. and Penzien J., "Dynamics of Structures", IInd Edition, McGraw hill, 1992.
10. Simiu E. and Scanlan R.H., "wind effects on Structures", Wiley, New York, 1978.
11. Codes of Practices (latest versions) such as API R-2A, bureau Veritas etc.
12. Rules for the design, construction and inspection of fixed offshore structures, 1977. Defnorske Veritas
13. Energy Department, U.K., Guidance of Design and Construction of Offshore Installation, 1974.
14. O.C. Zienkiewicz, R., Wlewis and K.G. Stagg, Numerical Methods in Offshore Engineering, Wiley Interscience Publication, 1978.

Semester VII

Course Code	Course Name	Credits
CEDLO7015	Department Level Optional Course-3 Advanced Construction Technology	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	--	--	--	100

Rationale

In today's times the construction activities are undergoing lots of changes/developments due to internal and globalized market demands of quality and faster completion of project works using modern techniques, use of modern and waste materials, and through mechanized construction. Today, we require high-capacity machines with better output and greater efficiency to make construction process less stressful. This course has been designed so that civil engineers would be able to use advanced construction technology. Student will be introduced to some emerging technologies in the field of Civil engineering which will make them more industry ready.

Objectives

1. To study and understand the latest construction techniques applied to engineering construction for sub structure.
2. To summarize the students about various techniques of super structure construction.
3. To give an experience in the implementation of new technology concepts which are applied in field of advanced construction in special structures.
4. To know the different methods of some advanced construction techniques and ground improvement techniques.
5. To present the new technology related to dredging system and its concepts related advanced construction technology.
6. To study different methods of rehabilitation and strengthening in construction to successfully achieve the structural design.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Sub Structure Construction		06
	1.1	Box jacking, Pipe jacking, Underwater drilling, blasting, and concreting. Underwater construction of diaphragm walls and basement	
	1.2	Driving well and caisson, sinking cofferdam, cable anchoring, and grouting. Driving diaphragm walls, sheet piles	
	1.3	Laying operations for built-up offshore system, Shoring for deep cutting, large reservoir construction, and well points. Dewatering for underground open excavation.	
II	Super Structure Construction for building		06
	2.1	Vacuum dewatering of concrete flooring, Concrete paving technology	
	2.2	Techniques of construction for continuous concreting operation in tall buildings of various shapes and varying sections, Erection techniques of tall structures, large span structures, launching techniques for heavy decks, in-situ prestressing in high rise structures, post-tensioning of the slab, aerial transporting, Handling, and erecting lightweight components on tall structures	
III	Construction of Special Structures		06
	3.1	Erection of lattice towers - Rigging of transmission line structures, Construction sequence in cooling towers, Silos, chimneys, skyscrapers. Construction sequence and methods in domes, Support structure for heavy equipment and machinery in heavy industries, Erection of articulated structures and space decks.	
	3.2	Roof truss: erection problems Building / Industrial component, Equipment and tackles used for erecting these. Plate girder Launching a portion of bridge girder, large span lattice girder. Erection of chimney, Erection of overhead tank.	
IV	Advancement in Construction techniques		08
	4.1	Building construction techniques: Zero energy building, green building, pre-engineering building, Solar Paints, Building Integrated Photovoltaic (BIPV), Earthquake Resisting Controls-Isolation and Dissipation.	
	4.2	Coastal construction techniques: Sound Proofing walls, water-resistant roofs, high-performance doors and windows, air and moisture barriers.	
	4.3	Road construction techniques: 3D Printing, Road Printer, smart roads	
	4.4	Ground improvement techniques: Advanced piling techniques - Stone Column, Vibro Floatation, Grouting, Geotextile application, Micro Piles, and Soil Nailing. Vertical drains-Sand Drains, Pre-Fabricated Vertical Drains. Thermal Methods- soil heating and soil freezing.	
V	Dredging		06
	5.1	Dredging System, Mechanism, Hydraulic dredger in waves, dredging equipment, Water & Booster System, dredging in the navigation system, Agitation dredging system, silt dredging system, water injection system,	

		Pneumatic dredging system, Amphibious & scrapper dredging system.	
	5.2	Advantages & Disadvantages of Various Dredging Systems, Production Cycle for Dredgers, Application, Capacity of dredgers, & its economical use, dredging economics	
VI	Rehabilitation and Strengthening Techniques		07
	6.1	Seismic retrofitting, strengthening of beams, strengthening of columns, strengthening of the slab, strengthening of a masonry wall, Protection methods of structures, Mud jacking and grouting for foundation, Micro piling and underpinning for strengthening floor and shallow profile, Subgrade waterproofing, Soil Stabilization techniques	
	6.2	Repair of steel structures, bridge, building, towers etc., monuments and historical structures. Prevention of water leakage in structures; Underwater repair; Durability of repairing material. Maintenance of underground railways.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

1. Evaluate the procedure of construction techniques for sub structure of major civil engineering projects.
2. Get a thorough knowledge of various stages of construction of super structure of major civil engineering projects.
3. Gain an experience in the implementation of new construction technology on engineering concepts which are applied in field Advanced construction technology in special structures.
4. Get a diverse knowledge of the different methods of advancement in construction techniques and ground improvement techniques.
5. Learn various dredging systems for major civil engineering projects.
6. Explain the theoretical and practical aspects of rehabilitation and strengthening techniques in civil engineering along with the design and management applications.

Internal Assessment

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test)

Average of marks will be considered for IA.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Roy Chudley and Roger Greeno , Construction Technology , Prentice Hall, 2005.
- 2 Dr. B.C. Punamia (2008); “Building Construction” Laxmi Publications (P) Ltd.ISBN13: 978-8131804285. 666p.
- 3 S. S. Bhavakatti (2012); “Building Construction” Vikas Publishing House Pvt Ltd. ISBN-13: 978-9325960794. 356p.
- 4 Peter. H. Emmons, “Concrete repair and maintenance illustrated”, Galgotia Publications Pvt. Ltd., 2001.
- 5 S. P. Arora and S. P. Bindra (2010); “Textbook of Building Construction”, Dhanpat Rai & Sons publication, ISBN-13: 978-8189928803. 688p
- 6 Sushil Kumar (2010); “Building Construction” Standard Publishes-Distributors. ISBN-13: 978-8180141683. 796p.
- 7 S.C. Rangwala, Building Construction, Charotar Publication Pvt Ltd. Anand

Reference Books:

- 1 Sankar, S.K. and Saraswati, S., Construction Technology, Oxford University Press, New Delhi, 2008.
- 2 Peurifoy, Construction Planning, Equipment and methods --Tata McGraw Hill Publication
- 3 Mahesh Varma , Construction Equipment Planning and Applications –
- 4 R. Chudley (revised by R. Greeno), Building Construction Handbook, Addison Wesley, Longman Group, England, 3rd ed.
- 5 S.S. Ataev, Construction Technology, Mir Publishers, Moscow
- 6 Robertwade Brown, "Practical foundation engineering hand book", McGraw Hill Publications.
- 7 Patrick Powers. J., Construction Dewatering: New Methods and Applications, John Wiley & Sons
- 8 Jerry Irvine, Advanced Construction Techniques, CA Rocketr

Semester VII

Course Code	Course Name	Credits
CEDLO7016	Department Level Optional Course-3: Pavement Materials, Construction and Maintenance	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Rationale

Highway and airways mode of transportation contributes to the economical, industrial, social and cultural development of any country. For the design and construction of highway and airfield, it is imperative to know the properties of the materials such as soil, aggregates and bitumen used in the construction of pavements. The various tests are required to be conducted to evaluate the properties of these materials for the scientific design of the pavements and economic utilization of the different materials. The course also deals with the soil survey, stresses in soil and various ways and means of improving the soil and implementing techniques of improvement. The course also deals with the various surface and sub-surface drainage.

Objectives

- 1 To give the students hands on experience on various material properties and testing procedures of pavement materials as per IRC standards. To study the soil classification for highway engineering purpose as per different classification system.
- 2 To understand the concept of stresses in soil. To enable the student to identify the basic deficiencies of various soil deposits and to arrive upon the various ways and means of improving the soil and implementing the techniques of improvement.
- 3 To understand the requirements of aggregates as per IRC code.
- 4 To learn bituminous types and mix designs.
- 5 To understand the different types of distresses in pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements. To study the construction of the concrete roads and low volume roads
- 6 To learn basic principles of super pave technology of bituminous mixes

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Soil		05
	1.1	Soil-Classification methods	
	1.2	Tests on Soil: CBR test, effect of lateral confinement on CBR and E value of Subgrade soil, Consistency, Engineering Properties and Modulus of sub-grade reaction of soil, estimation of modulus of subgrade reaction, Static and cyclic plate load test, correction for plate size, correction for worst moisture content.	
	1.3	Soil classification as per HRB.	
II	Stresses in Soil		08
	2.1	Theories of elastic and plastic behavior of soils, Cyclic triaxial test on subgrade soils, resilient deformation, resilient strain, resilient modulus.	
	2.2	Stabilized Soils: Method of sampling and Preparation of Stabilized Soils for testing, Relation for Moisture content and Dry Density of Stabilized mixes, UCS of Stabilized soil, test for: soil bituminous, soil lime and soil fly ash mixes. (IRC: SP:89 (Part II)-2018)	
III	Aggregates		04
	3.1	Classification, requirements, Blending of aggregates, Importance of aggregate shape factor in mix design	
	3.2	Grading requirements for aggregate, selection of bases and sub-base material (including stabilized materials),	
IV	Bitumen, Tar and Bituminous Mix Design		09
	4.1	Binders: Requirements, criteria for selection of different binders, Temperature susceptibility, Bituminous emulsion and Cutbacks, fillers, extenders Polymers, Crum rubber, and rubber modified bitumen and anti-Stripping agents on pavement performance.	
	4.2	Bituminous Mix Design: selection of different grade of bitumen, skid qualities, types of bituminous surfaces, bituminous mix design, Marshall Stability test, design aspect of paving concrete. Experimental characteristics of road aggregate.	
V	Evaluation and strengthening		09
	5.1	Flexible and rigid pavement distresses, condition and evaluation surveys, present serviceability index, roughness measurement, Benkelman beam deflections, skid resistance and measurement	
	5.2	Highway construction: Construction of WBM roads, Bituminous pavements, cement concrete roads, Reinforced concrete pavements construction.	
	5.3	Quality control (QC) and Quality assurance (QA) during construction of various pavements.	
	5.4	Low-Cost Roads (Rural Areas) (IRC-SP-20-2002) Classification of low-	

		cost roads, construction of low-cost roads.	
VI	Introduction to Super pave Technology		04
	6.1	Methods of selection of suitable ingredient for super pave method, Gyratory compaction, rolling thin film oven, pressure aging vessel, rotational viscometer, dynamic shear rheometer, bending beam rheometer, direct tension test.	
	6.2	Use of super pave perform and grade binder specifications. Comparison between Marshal Mix method and Super pave method.	

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Explain the soil classification in accordance with various soil classify the system and evaluate the ability of the soil as a subgrade material in terms of standard engineering parameters.
- 2 Describe the stress distribution in subgrade soil and the various ground improvement methods.
- 3 Evaluate the requirements and desirable properties of the aggregate to be used in the construction of pavements.
- 4 Compare the characterization of different surface paving (Bitumen) materials as per IRC code.
- 5 Explain the various causes leading to failure of pavement and remedies for the same and the construction of the concrete roads and low volume roads
- 6 Apply basic principles of mix design of cement concrete and bituminous mixes.

Internal Assessment

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average of marks will be considered for IA.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Highway Engineering; *Khanna, S.K., Justo, C.E.G. and Veeraragavan, A.*, Nem Chand and Brothers, Roorkee (10th Revised Edition, 2014)
- 2 Principles and Practices of Highway Engineering; *Dr. L. R. Kadiyali and Dr. N. B.Lal*, Khanna Publishers, New Delhi.
- 3 Highway Engineering, *Sharma, S.K.*, S. Chand Technical Publishers, New Delhi (3rd Revised Edition, 2013).

- 4 Principles of Transportation and Highway Engineering: *Rao, G.V.*, Tata Mc-Graw Hill Publications, New Delhi

Reference Books:

- 1 Principles of Pavement Design, Second Edition, 1975: *Yoder, E.J.*, John Wiley and Sons, Inc., New York.
- 2 Concrete Roads: *HMSO*, Road Research Laboratory, London.

Semester VII

Course Code	Course Name	Credits
CEDLO7021	Department Level Optional Course-4 Foundation Analysis and Design	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Practical	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

Foundation design is an important aspect of the vast field of civil engineering in general and geotechnical engineering in particular. A foundation designer has many diverse and important encounters with foundation design problems. The knowledge of foundation design is essential in design problems related to buildings, bridges, highways, tunnels, canals, or dams. The suitability of various types of foundations i.e. shallow foundation, pile foundation, well foundation etc. depends upon the bearing capacity of the soil, the pattern of stress distribution in the soil beneath the loaded area, the probable settlement of the foundation, effect of ground water, effect of vibrations, the magnitude of loads and ground water conditions etc. This course provides some important geotechnical aspects of the analysis and design of foundations.

Objectives

- 1 To estimate the vertical stresses in soil and to study the various practical applications.
- 2 To understand the design concepts for shallow foundations including strip and raft foundations and to understand applications of geocells.
- 3 To study the load carrying capacity and design of pile foundation.
- 4 To understand different types of well foundations and concept of floating foundations.
- 5 To analyze cantilever sheet piles including anchored sheet piles and to understand braced cuts system
- 6 To learn different types of machine foundations and understand the design philosophy.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Estimation of Stresses in Soils		04
	1.1	Boussinesque and Westergaard's theories	
	1.2	Newmark Chart	
	1.3	Practical applications.	
II	Shallow Foundation		06
	2.1	Determination of bearing capacity of shallow foundation by IS Code method	
	2.2	Settlement analysis of shallow foundation by IS code method	
	2.3	Geotechnical design of shallow foundation on rock and weathered rock	
	2.4	Geotechnical design of raft foundation.	
	2.5	Improvement in the bearing capacity of footings using geocells	
III	Pile Foundation		07
	3.1	Introduction, necessity of piles, types of pile foundations.	
	3.2	Load carrying capacity of single and group piles	
	3.3	Pile load test as per IS 2911 (Part I & Part II)	
	3.4	Geotechnical Design of single pile and pile cap as per IS 2911 and IRC 78	
IV	Floating Foundation and Well Foundation		06
	4.1	Introduction to floating foundation, floatation, bottom elastic heave	
	4.2	Design of floating foundation on piles	
	4.3	Introduction to well foundation, forces acting on well foundation.	
V	Sheet piles and Braced cuts		08
	5.1	Cantilever sheet piles including anchored sheet piles in cohesionless and cohesive soils, lateral earth pressure diagram, computation of embedment depth	
	5.2	Difference in open cut and retaining wall theories, apparent earth pressure diagram	
	5.3	Design of reinforced soil retaining walls	
	5.4	Estimation of strut loads in braced cuts placed in cohesionless and cohesive soils.	
VI	Machine Foundations		08
	6.1	Introduction, Dynamic soil properties as per IS 5249	
	6.2	Types of machine vibrations	
	6.3	Basic principles of machines foundation	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

1. Analyze vertical stress condition in soils.
2. Design a suitable foundation system.
3. Evaluate the safe allowable bearing capacity of shallow foundation and load carrying capacity of pile foundation under different soil conditions.
4. Explain concept of floating foundation.
5. Design different types of sheet piles.
6. Explain basic principles of machines foundation.

Internal Assessment

20 marks.

Consisting of Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of marks will be considered for IA.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

1. Terzaghi K. and Peck R. B., "Soil Mechanics in Engineering Practice", Wiley and Sons, 1996.
2. Alamsingh, "Soil Mechanics and Foundation Engineering", Vol I & Vol II, Standard book House, 2013.
3. Holtz, R.D. & Kovacs, W.D., "An introduction to geotechnical engineering", Prentice Hall, 1981.
4. Taylor D.W., "Fundamentals of soil mechanics, Asia publications Bombay, 1967.
5. Das B. M., "Shallow Foundation- Bearing Capacity & Settlement" Taylor & Francis, 2009.
6. Das B. M., "Principles of Foundation engineering", PWS Publishing Company, 2012.
7. Winterkorn H. and Fang F. Y., "Foundation Engineering Handbook", CBS Publishers & Distributors, New Delhi, 1990.
8. Robert M. Koerner, "Design with Geosynthetics", Pearson Prentice Hall, 2005.
9. G.V. Rao & G.V.S.S. Raju, "Engineering With Geosynthetics", Tata McGraw-Hill Pub Co Ltd, 1990.

Reference Books:

1. Bowles J. E., Foundation Analysis and Design, McGraw-Hill Book Co, 2001.
2. Shamsheer P. and Sharma H., Pile Foundations in Engineering Practice, Wiley and Sons, 1990.
3. Ranjan, Gopal & Rao, A.S.R., “Basic and applied soil mechanics”, New Age International Pvt. Ltd., 2004
4. Kramer S. L. Geotechnical Earthquake Engineering, Prentice Hall, 1996
5. Swami Saran, Soil Dynamics and Machine Foundation (2nd Ed.), Galgotia Publication Pvt Ltd.
6. Duncan C. Wyllie, “Foundations on Rock” CRC Press; 2nd edition 2019.
7. N.V. Nayak, “Foundation Design Manual” Dhanpat Rai Publications, 2018.

Semester VII

Course Code	Course Name	Credits
CEDLO7022	Department Optional Course-4 Solid and Hazardous Waste Management	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Rationale

Management of solid and Hazardous waste is a challenge for all developed and developing nations. Measures like proper collection, segregation, treatment, and solid waste disposal needs more attention in today's world. To achieve sustainable development proper solid waste management should be subjected to various types of waste treatments for obtaining value added products. Robust implementation of planned facilities for reuse, recycling, maximum resource recovery from various waste facilities, combined with safe residual waste disposal through sanitary landfills, incineration and novel methods of composting is initiated.

Objectives

1. To describe functional elements of solid waste management and its need.
2. To explain the segregation and transportation of municipal solid waste.
3. To recognize waste disposal methods and energy recovery techniques.
4. To comprehend the necessary knowledge and concepts of landfill for disposal.
5. To demonstrate hazardous waste management through its safe handling and disposal.
6. To identify assorted types of solid waste.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Municipal Solid Waste Management		06
	1.1	Sources, Types, Quantities, Composition, sampling of wastes, Properties of wastes, Numericals related to moisture content, density and Energy content, Problems and issues of solid waste management - Need for solid waste management- Awareness programme, Legal issues related to solid waste disposal	
	1.2	Functional Elements of SWM- waste generation (factors affecting), storage, collection, transfer and transport, processing, recovery and disposal in the management of solid waste.7R concept	
II	Waste Segregation, Storage, Collection and Transport		06
	2.1	Segregation - wet and dry method, Volume reduction at source, Recycling and Reuse of waste, Methods of collection - House to House collection, On site storage of municipal solid waste, Hauled container and stationary container system, Collection routes; Optimization of transportation routes, Numericals on container and collection systems.	
	2.2	Transfer station -Significance, Site selection, Types, Material Recovery facility	
III	Waste processing techniques and Energy Recovery		06
	3.1	Waste transformation- Biological and Thermal Biological Conversion Technologies – Composting, Factors affecting for composting, Various Composting Methods as Indore and Bangalore, Vermi, Mechanical and In vessel composting, Numericals on aerobic and anaerobic composting	
	3.2	Thermal conversion technologies – Incineration, Pyrolysis, Gasification, Refuse derived fuel	
IV	Landfills for Disposal of Waste		07
	4.1	Landfill Classification-Sanitary, Secure and Bioreactor, Design criteria for landfill site selection, operation and maintenance, Landfill methods -Trench, Area, Slope	
	4.2	Leachate generation, Characteristics and it's control methods. Landfill gas management and landfill closure	
	4.3	IoT in solid waste management	
V	Hazardous Waste Management		07
	5.1	Sources, Characteristics and classification of hazardous wastes, Storage, Handling, Collection, Transportation and Minimization, Need for Hazardous Waste Management	
	5.2	Treatment and Disposal	

		Hazardous Site remediation – onsite and offsite Techniques. Hazardous waste management using secure landfill, Disposal practices in Indian Industries, Hazardous Waste Management Rules 2016.	
VI	Assorted Solid Wastes		
	6.1	Biomedical waste Need for Biomedical Waste Management, Sources, Classification, Storage and Segregation- Color coding, Collection and Transportation, Treatment and Disposal. Latest Biomedical waste management rules. Electronic Waste Types, Component separation, Collection, Recycling and Recovery, E-waste management techniques and Latest E- waste management rules	07
	6.2	Plastic Waste Problems related to plastic wastes, Plastic waste management- Recycling & recovery, Energy production, Plastic waste management- Rules and Regulation Construction and Demolition waste Composition, Recycling and reduction, Proper Management	

Contribution to Outcome

After the completion of the course the learner should be able to:

1. Acquire the knowledge of functional elements of solid waste management.
2. Illustrate solid waste collection system, route optimization techniques, transfer station and processing of solid waste.
3. Develop the ability to plan waste minimization and processing of solid waste.
4. Explain approaches to treat the solid waste in the most effective manner for sustainable development.
5. Discuss safe methods of handling, management and disposal of hazardous waste.
6. Summarize waste management techniques used for assorted solid waste

Internal Assessment

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of marks will be considered for IA.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

1. Integrated Solid Waste Management: Techobanglous, Thisen and Vigil, McGraw Hill International.
2. Hazardous Waste Management: Lagrega, Buckingham and Evans, McGraw Hill International.
3. Solid Waste Management in Developing Countries: A.D. Bhide, Nagpur publications.
4. Environmental Pollution Control Engineering: C.S. Rao, Wiley Eastern, Manual of solid waste of management, CPHEEO.
5. E-Waste: Implications, Regulations, and Management in India and Current Global Best Practices, Rakesh Johri, The Energy and Resources Institute.
6. Biomedical Waste Management in India: Jugal Kishore and G. K. Ingle, Century Publications
7. Advances in Construction and Demolition Waste Recycling Management, Processing and Environmental Assessment, Fernando Pacheco-Torgal, Yining Ding, Francesco Colangelo, Rabin Tuladhar, Alexander Koutamanis.
8. Plastics Waste Management, Disposal Recycling and reuse, Marcel Dekker, Inc. New York, 1993-Nabil Mustafa.
9. CPHEEO, "Manual on Municipal Solid Waste Management" Central Public Health and Environmental Engineering Organization, Government of India, New Delhi , 2000.
10. MSW Rules 2016," Swachh Bharat Mission and Smart Cities Program of India.
11. Hazardous and other Wastes Management Rules,2016

Semester VII

Course Code	Course Name	Credits
CEDLO7023	Department Level Optional Course-4: Ground Improvement Techniques	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	--	--	03	--	--	03

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

A geotechnical engineer often needs to design new structures or repair the structures on or in problematic soils in engineering practices. The types of soil at construction sites are not always totally favorable for supporting civil engineering structure such as buildings, bridges, highways, tunnels, retaining walls, dams, offshore structures and many more. Soil needs to be treated using ground improvement techniques to enhance the soil strength. Specific types of soil improvement techniques are required for different problematic soils and situations, such as expansive and collapsible soils, liquefiable soils, karst deposits, foundation on dumps and sanitary landfills, earthquake prone areas, etc. This course will deal with different ground improvement techniques, their principles, effectiveness, design issues and areas of applications.

Objectives

- To enable students to identify problematic soils, associated issues and need for ground improvement.
- To make the students understand shallow and deep compaction techniques, importance of pre-compression and vertical drains.
- To make the students understand different soil stabilization techniques.
- To make the students learn the concepts, purpose and effects of grouting.
- To make the students understand application of stone column technique.
- To provide students the concept of reinforced earth, soil nailing and ground anchors.

Detailed Syllabus

Module	Course Module/ Contents	Periods
I	Introduction	07
	Different types of problematic soils and concerns (inadequate mechanical properties, swelling and shrinkage - expansive soils, collapsible soils, marshy and soft soils, organic/ peaty soils, loose sandy or gravelly deposits, liquefiable soils, karst deposits, foundation on dumps and sanitary landfills, old mine pits, etc.); Need for ground improvement; Control of ground improvement works; Ground improvement techniques for different soil types (principles, applicability to various soil conditions, material requirements, equipments required, results likely to be achieved and limitations); Grain size ranges for different treatment methods; Classification of ground modification techniques; Factors affecting the selection of ground improvement techniques; Benefits/objectives of ground improvement techniques, Emerging trends in ground improvement techniques (Types and brief discussion on constructive use of waste materials, low cost technologies with soil and additives, Geosynthetics, biotechnical stabilization, etc.) Note: Refer IS 13094 (1992): “Selection of ground improvement techniques for foundation in weak soils – Guidelines”	
II	Compaction and Consolidation	07
	Shallow compaction: laboratory and field methods of compaction, compaction curve, advantages of compaction, effect of compaction; Deep compaction: objectives, brief discussion on dynamic compaction (types of dynamic compaction, evaluation of improvement), dynamic consolidation, dynamic replacement, Vibro-compaction or, Vibro-floatation, Vibro replacement, blasting; Precompression and vertical drains: Precompression or preloading (principle, settlement without and with Precompression), accelerated consolidation by sand drains, free strain and equal strain cases, design of sand drain layout; Brief discussion on prefabricated vertical drains (PVDs), advantages of PVDs over sand drains	
III	Stabilization of Soil	05
	Methods of stabilization; mechanical stabilization; lime, cement, fly-ash, bitumen, chemicals and polymer stabilization; Electrokinetic stabilization	

IV	Grouting	06
	Grouting technology, grout materials, choice of a grout material, classification, general relationship between permeability and groutability; Particulate grouts: characteristics of grout materials, characteristics of grout slurries; Non-particulate grouts: types of chemical grouts, salient features of chemical grouts, grout properties (mechanical properties, chemical properties, economic factors), penetrability and performance aspect of coarse and fine grouts, limits of groutability based on grain size distribution; Various applications of grouting. Note: Refer IS 14343:1996 “Choice of Grouting Materials for Alluvial Grouting – Guidelines”	
V	Stone Columns	07
	Some important features of stone column treatment: influence of soil type, influence of construction methodology, treatment depth, area of treatment; Basic design parameters: stone column diameter, pattern, spacing, equivalent diameter, replacement ratio, stress concentration factor; Failure mechanisms; Design considerations; Estimation of load capacity of a stone column (unit cell concept); Settlement analysis by the reduced stress method; Granular blanket; Field loading tests; Installation techniques of stone columns: non-displacement method, displacement method, vibro-replacement method; Vibrofloat and rammed stone columns; Methods of improving the effectiveness of stone column Note: Refer IS 15284-1 (2003): “Design and construction for ground improvement - Guidelines, Part 1: Stone columns”	
VI	Reinforced Earth and Anchors	07
	Theory of reinforced earth concept; Design principles of reinforced earth through Mohr circle analysis; Necessity of reinforced earth; Materials; Introduction to Geosynthetics: scope and definitions, multiple functions of Geosynthetics (Separation, Filtration, Drainage, Reinforcement, Protection (Cushion), Barrier/Containment/Waterproofing, Erosion Control), areas of applications; Introduction to soil nailing and ground anchors; Capacity of shallow horizontal strip anchor by using Mononobe-Okabe method.	
Total		39

Contribution to Outcome

After successful completion of the course, students will be able to:

1. Identify the problems associated with the existing ground conditions and recognize the need for ground improvement.
2. Explain shallow and deep compaction techniques, pre-compression and vertical drains as well as estimate maximum dry density and consolidation settlement.
3. Evaluate soil stabilization and select the effective soil stabilization technique.
4. Apply knowledge of grouting as per IS 14343:1996.
5. Design stone column as per IS 15284-1 (2003).
6. Describe reinforced earth mechanism, multiple functions of Geosynthetics and evaluate capacity of anchors.

Theory examination:

1. The question paper will comprise of **six** questions; each carrying 20 marks.
2. The first question will be **compulsory** and will have short questions having weightage of 4-5 marks covering the entire syllabus.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any **three** questions out of remaining five questions.
5. Total four questions need to be attempted.

Recommended Books:

1. P. P. Raj (2016). “Ground Improvement Techniques”, Second edition, Laxmi Publications (P) LTD.
2. M. R. Hausmann (1990). “Engineering Principles of Ground Modification”, McGraw-Hill Inc.,US.
3. IS15284 (Part 1): Design and Construction for Ground Improvement–Guidelines: (Stone Column), Bureau of Indian Standards, New Delhi, (2003).
4. Nihar Ranjan Patra (2012). “Ground Improvement Techniques”, Vikas Publishing.
5. S. L. Kramer (2013). “Geotechnical Earthquake Engineering”, Pearson.
6. B. M. Das (1990). “Earth Anchors”, Elsevier.

Reference Books and IS Codes:

1. IS 13094 (1992): “Selection of ground improvement techniques for foundation in weak soils – Guidelines”
2. IS 14343:1996 “Choice of Grouting Materials for Alluvial Grouting – Guidelines”
3. IS 15284-1 (2003): “Design and construction for ground improvement - Guidelines, Part 1: Stone columns”
4. R.M. Koerner (1984). “Constructional and Geotechnical Methods in Foundation Engineering (McGraw-Hill series in construction engineering and project management), McGraw-Hill Inc.,US.
5. FHWA Report No. Rd 83/026, (1983) Design and Construction of Stone Columns, Vol I.
6. B. M. Das (2011). “Principles of Foundation Engineering”, 7th edition, Cengage Learning.
7. R.M.Koerner (1999). “Designing with Geosynthetics”, 4th Edition, Prentice Hall, Jersey.

Semester – VII								
Course Code			Course Name					Credits
CEDLO7024			Department Level Optional Course-4: Green Building Constructions					03
Contact Hours			Credits Assigned					
Theory	Practical	Tutorial	Theory		Practical	Tutorial		Total
03	--	--	03		--	--		03
Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test–I	Test–II	Average						
20	20	20	80	3 hours	--	--	--	100

Rationale

Globally, buildings are responsible for a huge share of energy, electricity, water and materials consumption. As of 2018, buildings account for 28% of global emissions or 9.7 billion tonnes of CO₂. The United Nations' 2020 global status report and other sources detail that around 35 - 40% of globally generated energy was used by buildings; which also contributed to 33% of worldwide emissions. If new technologies in construction are not adopted during this time of rapid growth, emissions could double by 2050, according to the United Nations Environment Program. Green building construction practices aim to reduce the environmental impact of building as the building sector has the greatest potential to deliver significant cuts in emissions at little or no cost. As civil engineering graduates, it is of utmost importance to have a deep understanding of the concepts and technologies involved in the sustainable development with respect to the construction industry. It is also further desirable for the graduates to have an in-depth knowledge of the green rating systems as well as green auditing & green retrofitting – which will have tremendous scope in the future.

Objectives

1. To outline the environmental impact of buildings
2. To explain the concepts of sustainable development and green building
3. To summarize the features of green buildings
4. To explain green building rating systems
5. To describe green audit
6. To explain green retrofitting

Detailed Syllabus			
Module	Course Modules / Contents		Duration
I	Introduction		3
	1.1.	Environmental impact of buildings, concept of sustainable development, concept of green buildings, necessity of green buildings, benefits of green buildings	
	1.2.	Overview of features of green building – design and construction efficiency, water efficiency, energy efficiency, materials efficiency, indoor environmental quality, waste reduction, operations and maintenance	
	1.3.	Examples of green buildings	
II	Site Selection, Planning and Design		8
	2.1.	Site preservation	
	2.2.	Passive architecture	
	2.3.	Soil erosion control	
	2.4.	Natural topography and on-site vegetation	
	2.5.	Preservation of transportation of trees on-site	
	2.6.	Heat island reduction	
	2.7.	Optimization in structural design	
III	Water Conservation and Energy Efficiency		10
	3.1.	Rainwater harvesting	
	3.2.	Water efficient plumbing fixtures	
	3.3.	Irrigation systems	
	3.4.	Wastewater treatment and reuse	
	3.5.	Water metering	
	3.6.	Wastewater reuse during construction	
	3.7.	Minimum and enhanced energy efficiency	
	3.8.	Commissioning plan for building equipment and systems and post-installation	
	3.9.	On-site and off-site renewable energy	
IV	Green building materials and indoor environmental quality		10
	4.1.	Sustainable building materials	
	4.2.	Use of certified green building materials, products & equipment	
	4.3.	Segregation of waste, organic waste management and handling of waste materials	
	4.4.	Fresh air ventilation	
	4.5.	CO ₂ monitoring	
	4.6.	Day lighting	
	4.7.	Minimizing of indoor and outdoor pollutants	
	4.8.	Low-emitting materials	
	4.9.	Occupant well-being facilities	
4.10	Indoor air quality testing, after construction and before		

		occupancy	
	4.11	Indoor air quality management	
V	Green building rating systems		4
	5.1.	Introduction to green building rating systems	
	5.2.	Overview of various green building rating systems	
	5.3.	Indian Green Building Council (IGBC) rating system – overview, benefits of new green buildings, overview of certification process and project checklist	
VI	Green audit and green retrofitting		4
	6.1.	Green audit: pre-audit, on-site audit and post-audit report	
	6.2.	Case study of any one green building audit	
	6.3.	Green retrofit – overview, components of green retrofit: integrated design, occupant behaviour, lighting retrofits, HVAC retrofits, window retrofits, green roof retrofits	

Contribution to Outcomes

On completion of this course, students will be able to:

1. Explain environmental impact of buildings, discuss the concepts of sustainable development & green buildings and overview the features of green buildings
2. Describe site selection, planning and designing of green buildings
3. Explain water conservation and energy efficiency in green buildings
4. Identify green building materials and indoor environmental quality
5. Apply green building rating systems
6. Describe green audit and green retrofitting

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only four questions need to be solved.

Recommended Books:

1. Green Building: Principles and Practices by Dr. Adv. Harshul Savla (Notion Press)
2. The Idea of Green Building by A. K. Jain (Khanna Publishers)
3. Green Building Guidance: The Ultimate Guide for IGBC Accredited Professional Examination by Karthik Karuppu (Notion Press)

4. Green Building Materials & Implementation by Dr. V. Murugesh (Notion Press)
5. Green Building Fundamentals by G. Harihara Iyer (Notion Press)

Reference Books/Links:

1. Indian Green Building Council (IGBC) web-site: <https://igbc.in/igbc/>
2. Leadership in Energy & Environmental Design (LEED) web-site: <https://www.usgbc.org/leed>
3. Green Building: Principles & Practices in Residential Construction by Abe Kruger and Carl Seville (Delmar Cengage Learning)
4. Green Building through Integrated Design by Jerry Yudelson (McGraw Hill)
5. Green Building Handbook: Volume 1: A Guide to Building Products and their Impact on the Environment by Tom Wooley, Sam Kimmins, Rob Harrison and Paul Harrison (Routledge Publishers)

Semester VII

Course Code	Course Name	Credits
CEDLO7025	Department Level Optional Course- 4: Legal Aspects in Construction	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	--	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Practical	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Construction industry is one of the most regulated industries in the World and subjected to various laws, rules, and regulation and ethical standards. A civil Engineering graduate must be able to understand and interpret these laws and navigate through these environments with utmost certainty and responsibilities.

The syllabus of this course has been designed to give preliminary introduction to Civil Engineering about legal aspects in construction industry. Along with this, the course intend to help students understand various aspects of contracts, tenders and roles & responsibilities of various involved individual and parties.

Objectives

- 1 To explain needs of various laws and legislation related to Construction Industry.
- 2 To summarize application of various Contracts and their forms (Documents)
- 3 To describe application of various Tenders and their forms (Documents)
- 4 To understand needs & Methods of arbitration and dispute resolution mechanism
- 5 To explain needs health, safety and labour laws associated with Construction Industry
- 6 To describe needs of Environmental protection and ethics in Construction Industry

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Introduction to Legal Aspects in Construction Industry		6
	1.1	Need of laws in the construction industry. Role of Builders, Engineers, Architects and Contractors.	
	1.2	Need for legislation. Important Laws related to construction industry: Indian Contract Act 1872, Labour laws, The Building and Other Construction Workers Act, 1996, The Environment (Protection) Act, 1986.	
II	Contracting in Construction		8
	2.1	Contract: Definition, Purpose and Sanctity of Contract, Classification of Construction Contracts and their advantages and disadvantages: Lump-Sum Contract, Unit Price Contract, Cost-Plus Contract and Target Contract. Types of Documents (Forms) in a Construction Contract.	
	2.2	Contract Management: Indian Contract Act- 1872, Breach of Contract and Professional ethics to be followed by Contracting Parties.	
III	Tendering in Construction		6
	3.1	Tender: Definitions. Requisites of a Valid Tender Types of Tendering: Open Tendering, Selective Tendering and Negotiated Tendering.	
	3.2	Tender Documents, Scrutinization process, Award, acceptance, Bidding models & bidding strategies. E-Tendering process of PWD.	
IV	Arbitration and Dispute Resolution		6
	4.1	Claims & disputes, Standard methods of resolving disputes.	
	4.2	Dispute Resolution Board (DRB) – Necessity, formation, Functioning, Advantages etc	
	4.3	Arbitration & conciliation Act -1996 – Arbitration agreement, Arbitration process, duties & powers of an arbitrator, rules of preparing evidence, Publication of an award.	
V	Health, Safety and Labour Laws		6
	5.1	Safety rules on construction sites. Roles and responsibilities of owner, contractor and engineers on site.	
	5.2	Important laws: BOWC Act 1996	
	5.3	Minimum Wage Act, 1948	
	5.4	GST Tax Act 2017	
VI	Environmental Protection and Ethics		7
	6.1	Impact of construction industry in global warming and climate change. Environmental impact assessment report and case study of any recent infrastructure project.	

	6.2	Paris agreement 2020 and Indian's Climate target as per Paris agreement.	
	6.3	Ethical responsibilities of Civil Engineers, contractors and other parties in construction.	

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Explain needs of various laws and legislation related to Construction Industry.
- 2 Describe application of various Contracts and their forms (Documents)
- 3 Describe application of various Tenders and their forms (Documents)
- 4 Evaluate needs & Methods of arbitration and dispute resolution mechanism
- 5 Explain health, safety and labour laws associated with Construction Industry
- 6 Apply needs of Environmental protection and ethics in Construction Industry

Internal Assessment

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Manual for Procurement of Works 2019 GoI, Ministry of Finance
- 2 PWD manual for E-tendering 2018 PWD, India
- 3 Construction contracts and claims - Simon M.S., McGraw Hill, New York
- 4 Construction contracts Management- NICMAR Publication India
- 5 Estimation and contracts B.S. Patil

Reference Books:

- 1 Construction contracts and claims - Simon M.S., McGraw Hill, New York
- 2 Construction contracts Management- NICMAR Publication India

Semester VII

Course Code	Course Name	Credits
CEDLO7026	Department Level Optional Course-4: Environmental Impact Assessment	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	03 hours	--	--	--	100

Rationale

Environmental impact assessment is the formal process used to predict the environmental consequences (positive or negative) of a plan, policy, program, or project prior to the decision to move forward with the proposed action. An impact assessment may propose measures to adjust impacts to acceptable levels or to investigate new technological solutions. This subject covers the study of environmental assessment process, environmental auditing and provisions of various environmental acts of India.

Objectives

- 1 Students will learn about sustainable development
- 2 Students will learn different steps within environmental impact assessment
- 3 Students will learn how to use of EIA for various projects
- 4 Students will learn the need to assess and evaluate the impact on environment.
- 5 Students will learn about Environmental Audit
- 6 Students will learn Major principles of environmental impact assessment

Detailed Syllabus

Module	Course Module / Contents	Periods
I	Environmental impact assessment	5
	What is it, Environmental attitudes, Brief history of EIA, Significance of EIA, Role of EIA in planning and decision making process, objectives of EIA.	

II	Environmental assessment process Assessment methodology, Socioeconomic impact assessment, Air quality impact analysis, Noise impact analysis, Energy impact analysis, Water quality impact analysis, Vegetation and wild life impact analysis, Cumulative impact assessment, Ecological impact assessment, Risk assessment.	8
III	Environmental Impact Assessment Process Basic concept behind EIS, Stages in EIS production: Screening, scoping, prediction, evaluation, reducing impact, monitoring, conclusions, typical EIS outline	5
IV	Rapid EIA Rapid EIA, when it is carried out, advantages and disadvantages	6
V	Environmental Auditing Definition, aims and objectives, audit principles, incentives to undertake audit, partial environmental audits, stages of implementing environmental audits, scope of audit	7
VI	Provisions of various environmental acts of India various environmental acts of India, Case studies	8

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Demonstrate the understanding of concept of Sustainable Development and justify the methods of achieving Sustainable Development.
- 2 Overview of assessing risks posing threats to the environment
- 3 List and evaluate different risks associated with given project
- 4 Conduct Environmental Audit
- 5 Explain the importance of stakeholders in the EIA process
- 6 Conduct different case studies/examples of EIA in practice

Internal Assessment

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.

- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Corporate Environmental Management: Welford R, University Press
- 2 Environmental Assessment: *Jain R K*, Mc-Graw Hill
- 3 Environmental Impact Assessment: *Harry W Conter*, Mc-Graw Hill
- 4 Environmental Impact Assessment – Handbook: *John G Rau* and *D C Wooren*, Mc-GrawHill.
- 5 Introduction to Environmental Impact Assessment, A Chadwick, Taylor & Francis , 2007
- 6 Environmental Impact Assessment, Barthwal, R. R. New Age International Publications
- 7 Environmental Impact Assessment, Larry Canter, McGraw-Hill Publications

Reference Books:

- 1 Strategic Environmental Assessment, R. Therirvel, E. Wilson, S. Hompson, D. Heaney, D. Pritchard, Earthscan, London , 1992
- 2 A Practical Guide to Environmental Impact Assessment, Paul, A Erickson, Academic Press , 1994
- 3 Handbook of Environment Impact Assessment by Judith Petts; McGraw Hill publications
- 4 Environmental Impact Assessment: Theory & Practice, Wathern, P, Publishers- Rutledge, London, 1992.

Subject Code	Subject Name	Credits
CEDLO7027	Department Level Optional Course-4: Advanced Design of Steel Structures	03

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test	Test	Average						
20	20	20	80	--	--	--	--	100

Rationale

The civil engineering structures are subjected to different types of loading and their combination. Many of the structure are made of steel , these structure are design by working stress method and limit state method . The design method of different component are given in the syllabus are based on limit state method and working state method.

Objectives

- To understand the design philosophies of Working stress and Limit state methods and
- design of moment resistant connections.
- To explain the design concept of gantry girder
- To understand the analysis and design concept of round tubular structures
- To describe the design concept of different type of steel water tank
- To explain the design concept of lattice tower
- To describe the design concept of steel chimney.

Detailed Syllabus

Module	Sub – Modules / Contents	Periods
I	Introduction to Steel Structure and Moment Resistant Beam End Connections:	07
	Introduction to type of steel, mechanical properties of Structural steel, advantages of steel as structural material, design philosophies of Working Stress Method (WSM) , Limit state method and design of simple riveted connection. Design of moment resistant bolted and welded beam end connections by limit state method	
II	Gantry Girder :	06
	Loads acting on gantry girder, Analysis of gantry girder, design of gantry girder by limit state method.	
III	Round Tubular Structural Members :	06
	Properties of steel tubes, design of tension member and compression members, design of welded connections, design of flexural members, analysis and design of tubular trusses including purlins and supports	
IV	Elevated Steel Tanks and Stacks :	08
	Loads acting on tanks including wind and earthquake, design of circular tanks with hemispherical and conical bottom, supporting ring beam, staging for circular tanks including design of columns and foundation,	
V	Lattice Tower:	06
	Different configuration of lattice towers, loads acting on lattice towers, Analysis of lattice tower,	
VI	Steel Chimney :	06
	Forces acting on chimney, design of self supporting welded and bolted chimney and components including design of foundation.	

Contribution to Outcomes

On completion of this course, the students will be able to

1. Analyze and design Moment Connection.
2. Analyse and design gantry girder by limit state method.
3. Analysis and design of tubular truss using IS code.
4. Analysis and design of Elevated water tank using IS code.

5. Analyze and design Lattice Tower using IS code.
6. Analyze and design Steel Chimney using IS code.

1 Theory Examination:-

1. Question paper will comprise of six question; each carrying 20 marks.
2. The first question will be compulsory.
3. The remaining five questions will be based on all the modules of the entire syllabus. For this, the modules shall be divided proportionately and further, the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
4. The students will have to attempt any three questions out of remaining five questions.
5. Total four questions need to be attempted

Internal Assessment

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of marks will be considered for IA.

Term Work (this may be included in content beyond syllabus / optional)

The Term work shall consist of a Design report and detailed drawings on any two projects as indicated below:

1. Roofing system including details of supports using tubular section
2. Design of elevated circular tank with conical bottom steel tank.
3. Design of lattice tower or steel chimney.

The drawing should be drawn in pencil only on minimum of A-1 (imperial) size drawing sheets.

Recommended Books:

- 1 Design of Steel Structures : N Subramanian, Oxford- University Press
- 2 Design of Steel Structures: Punamia, A. K. Jain & Arun Kumar Jain . Laxmi Publication
- 3 Design of Steel Structures: Dayaratnam, Wheeler Publication, New Delhi.
- 4 Design of steel structures: Krishnamachar B.S, & Ajitha Sinha D.

Reference Books:

1. Design of Steel Structures: Mac. Ginely T.
2. Design of Steel Structures: Kazimi S. M. & Jindal R. S., Prentice Hall of India.
3. Design of Steel Structures: Breslar, Lin and Scalzi, John Willey, New York.

4. Design of Steel Structures: Arya and Ajmani, New chand & Bros.
5. Relevant IS codes, BIS Publication, New Delhi
6. Steel structures, Controlling behavior through design: R. Englekirk, Wiley
7. LRFD Steel Design : William T. Segui, PWS Publishing
8. Design of Steel Structures: Edwin H. Gaylord, Charles N. Gaylord and James. Stallmeyer, McGraw-Hill

Semester VII		
Course Code	Course Name	Credits
ILOC7011	Institute Level Optional Course – I : Product Life-cycle Management	03

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Module	Detailed Contents	Hrs
I	Introduction to Product Life-cycle Management (PLM): Product Life-cycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
II	Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The	09

	Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
III	Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
IV	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
V	Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
VI	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Contribution to Outcomes:	
Students will be able to • Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. • Illustrate various approaches and techniques for designing and developing products. • Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc. • Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant	

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Life-cycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Semester VII		
Course Code	Course Name	Credits
ILOC7012	Institute Level Optional Course – I : Reliability Engineering	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Module	Detailed Contents	Hrs
I	Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
II	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
III	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
IV	Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08

V	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
VI	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

Outcomes

Students will be able to...

- Explain and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out failure mode effect and criticality analysis

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillon, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Connor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Semester VII		
Course Code	Course Name	Credits
ILOC7013	Institute Level Optional Course – I : Management Information System	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:	
- The course is blend of Management and Technical field. - Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built - Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage - Identify the basic steps in systems development	

Module	Detailed Contents	Hrs
I	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
II	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
III	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
IV	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
V	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
VI	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Contribution to Outcomes

Students will be able to:

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Evaluate the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Teaching Scheme

Semester VII						
Course Code		Course Name				Credits
ILOC7014		Institute Level Optional Course – I: Design of Experiments				03
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand the issues and principles of Design of Experiments (DOE)
- To list the guidelines for designing experiments
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Module	Detailed Contents	Hrs
I	Introduction 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
II	Fitting Regression Models 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
III	Two-Level Factorial Designs 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
IV	Two-Level Fractional Factorial Designs	07

	4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	
V	Response Surface Methods and Designs 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
VI	Taguchi Approach 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Contribution to Outcomes	
Students will be able to	
- Plan data collection, to turn data into information and to make decisions that lead to appropriate action - Apply the methods taught to real life situations - Plan, analyze, and interpret the results of experiments	

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

- Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
- D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
- George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation

and Discovery, 2nd Ed. Wiley

4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc.
ISBN: 0-471-39054-2
5. Design and Analysis of ExperimENTS (Springer text in Statistics), Springer by A.M. Dean, and

Semester VII		
Course Code	Course Name	Credits
ILOC7015	Institute Level Optional Course – I : Operations Research	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20						

Objectives:
- Formulate a real-world problem as a mathematical programming model. - Understand the mathematical tools that are needed to solve optimization problems. - Use mathematical software to solve the proposed models.

Module	Detailed Contents	Hrs
I	Introduction to Operations Research: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel’s approximation method. Optimality test: the stepping stone method and MODI method. Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	14

	Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
II	Queuing models: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
III	Simulation: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
IV	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
V	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
VI	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Outcomes:

Students will be able to

- Explain the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Describe the applications of integer programming and a queuing model and compute important performance measures

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Lieberman, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Semester VII		
Course Code	Course Name	Credits
ILOC7016	Institute Level Optional Course – I : Cyber Security and Laws	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:
- To understand and identify different types cyber crime and cyber law - To recognized Indian IT Act 2008 and its latest amendments - To learn various types of security standards compliances

Module	Detailed Contents	Hrs
I	Introduction to Cyber crime: Cyber crime definition and origins of the world, Cyber crime and information security, Classifications of cyber crime, Cyber crime and the Indian ITA 2000, A global Perspective on cyber crimes.	4
II	Cyber offenses & Cyber crime: How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cyber crimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
III	Tools and Methods Used in Cyber line Phishing, Password Cracking, Key loggers and Spy-wares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
IV	The Concept of Cyberspace E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8

V	Indian IT Act. Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
VI	Information Security Standard compliances SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Outcomes

Students will be able to:

- Explain the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
6. Kenneth J. Knapp, Cyber Security & Global Information Assurance Information Science Publishing.
7. William Stallings, Cryptography and Network Security, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional : <https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

Semester VII		
Course Code	Course Name	Credits
ILOC7017	Institute Level Optional Course – I : Disaster Management and Mitigation Measures	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20						

Objectives	
- To understand physics and various types of disaster occurring around the world - To identify extent and damaging capacity of a disaster - To study and understand the means of losses and methods to overcome /minimize it. - To describe role of individual and various organization during and after disaster - To explain application of GIS in the field of disaster management - To understand the emergency government response structures before, during and after disaster	

Module	Detailed Contents	Hrs
I	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
II	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
III	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and	06

	how to proceed in due course of time, study of flowchart showing the entire process.	
IV	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and software for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
V	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
VI	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and Don'ts in case of disasters and effective implementation of relief aids.	06

Contribution to Outcome

Students will be able to...

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structure associated with an emergency.
- Get to know the simple do's and don'ts in such extreme events and act accordingly.

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. 'Disaster Management' by Harsh K. Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S. Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS – C.P. Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.
(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Semester VII		
Course Code	Course Name	Credits
ILOC7018	Institute Level Optional Course – I : Energy Audit and Management	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	

Objectives:	
- To understand the importance energy security for sustainable development and the fundamentals of energy conservation. - To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management - To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.	

Module	Detailed Contents	Hrs
I	Energy Scenario: Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
II	Energy Audit Principles: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
III	Energy Management and Energy Conservation in Electrical System: Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings.	10

	Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
IV	Energy Management and Energy Conservation in Thermal Systems: Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
V	Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
VI	Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Outcomes:

Students will be able to:

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed.

The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Semester VII		
Course Code	Course Name	Credits
ILOC7019	Institute Level Optional Course – I : Development Engineering	03

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a ‘good’ human being, a ‘good’ professional, a ‘good’ society and a ‘good life’ in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Module	Detailed Contents	Hrs.
I	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
II	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people’s participation and Panchayati Raj; Ashok Mehta Committee- linkage between Panchayati Raj, participation and rural development.	04
III	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the	06

	weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
IV	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
V	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	10
VI	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Outcomes: Learner will be able to...

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part

(a) from module 3 then part (b) will be from any module other than module 3)

4. Only Four questions need to be solved

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 40

Semester-VII

Course Code	Course Name	Credits
CEL701	Design and Drawing of Reinforced Concrete Structures	1

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
--	--	2	--	--	1	1

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
--	--	--	--	--	25	--	25	50

Course Objective:

1. To explain the LSM design procedure of G+ 3 RCC framed Building by application of IS code clauses including loading calculation, analysis and design of individual elements with detailing of reinforcements.
2. To explain the concept in the design of water tanks.
3. To explain the concept in the design of retaining walls.
4. To introduce the basics of structural dynamics, structural behavior under the dynamic load and the effect of damping.
5. To introduce earthquake resistant design approach.
6. To develop the practice of design using charts and tables from SP:16 published by BIS.
7. To introduce concept of Pre-stressed Concrete.

Course Outcomes:

At the end of the course, learner will be able to:

1. Design G+3 RCC framed building using IS code recommendations.
 2. Design different types of water tanks with detailing of reinforcement.
 3. Design different types of retaining walls with detailing of reinforcement
 4. Apply the basic concepts of structural dynamics
 5. Explain response of structure during an earthquake and calculate design forces.
 6. Explain principles of Prestressed Concrete and its losses.
-

List of Tutorials and Assignments		
Week (Activity)	Detailed Content	Hours
1 st Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Drawing of structural plan on Sheet no. 1)	02
2 nd Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of Staircase)	02
3 rd Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of simply supported and continuous one way and two-way slabs and detailing of reinforcement for slabs including staircase on sheet no. 2)	02
4 th Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of simply supported and continuous Beams and Detailing of reinforcement for beams on sheet no. 3)	02
5 th Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of Columns and Detailing of reinforcement for columns on sheet no. 4)	02
6 th Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of isolated & combined footing and Detailing of reinforcement for footing on sheet no. 5)	02
7 th Week (Assignment)	Assignment no. 1 Introduction to Structural Dynamics (Maximum 5 Questions)	02
8 th Week. (Assignment)	Assignment no. 2 Earthquake resistant design of structures (Maximum 5 Questions)	02
9 th Week (Tutorial)	Project – II – Design of Counterfort retaining wall Design of the elements of counterfort retaining wall using LSM	02
10 th Week (Tutorial)	Project – II – Design of Counterfort retaining wall (Detailing of reinforcement of counterfort retaining wall on sheet no. 6)	02
11 th Week (Assignment)	Assignment no. 3 Design of water tanks using WSM (Maximum 5 Questions)	02
12 th Week (Assignment)	Assignment no. 4 Introduction to prestressed concrete Maximum 5 Questions	02
13 th Week	Viva – Voce Examination	02

Assessment:

- **Term Work**

The Term work shall consist of neatly written design report on Project – I & II & reinforcement detailing on A2 size sheets of paper, detailed drawings using AutoCAD and Assignments 1 to 4. A visit to be conducted at RCC or Prestressed concrete construction site and a detailed report to be submitted by the groups of students. Students may be asked to check manual calculations with available structural design software.

Distribution of marks for Term Work shall be as follows:

Tutorial Work	:	15 Marks
Assignments & Site Visit Report	:	05 Marks
Attendance	:	05 Marks

- **End Semester Oral and Sketching Examination**

Oral examination will be based on entire syllabus and sketching examination will be conducted for 60 minutes duration before oral examination.

Recommended Books:

1. Design of Reinforced Concrete Structures: *Dayaratnam, P*; Oxford and IBH.
2. Reinforced Concrete - Limit State Design: Ashok K. Jain, Nemchand & bro.
3. Limit State Design of Reinforced Concrete: Shah and Karve, Structure Publications, Pune.
4. Design of Prestressed Concrete Structures: Lin T.Y. and Ned Burns; John Wiley.
5. Reinforced Concrete: H.J. Shah, Charotar Publishers, Anand.
6. Prestressed concrete : Krishna Raju, Tata Mc-Graw Hill Publishing House, New Delhi
7. Illustrated Reinforced Concrete Design: Dr. V. L. Shah and Dr. S. R. Karve, Structure Publications, Pune.
8. Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A, John Wiley (2007), 7th Edition.
9. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.

Reference Books:

1. Design of RCC structural Elements (RCC Vol-I): Bhavikatti, S. S., New Age International Publications.
2. Reinforced Concrete: Syal and Goel; Wheeler Publishers.
3. Reinforced Concrete Design: Pillai, S.U. and Menon, Devdas, Tata Mc-Graw Hill Publishing House, New Delhi.
4. Reinforced Concrete Design by S.N. Sinha, Tata Mc-Graw Hill Publishing House, New Delhi.
5. Theory of Reinforced concrete structures by N. Subramanian, Oxford University Press.
6. Prestressed concrete : N. Rajgopalan, Narosa Publishers.
7. Earthquake resistant design of structures: Pankaj Agarwal, Manish Shrikhande, PHI, New Delhi.
8. Relevant IS Codes: BIS Publications, New Delhi.

Semester VII

Course Code	Course Name	Credits
CEL702	Quantity Survey, Estimation & Valuation	1

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
--	--	2	--	--	1	1

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
--	--	--	--	--	25	--	25	50

Course Objective:

1. To emphasize the importance of relevant IS: 1200 - 1964 codes and understand measurement systems for various items of civil engineering structures
2. To draft the specifications for various items of work & determine unit rates of items of works by preparing rate analysis
3. To study the various methods of detailed and approximate estimates.
4. To calculate the quantity of earthwork by using various methods.
5. To study the process of tendering and its various stages, various types of contracts, its suitability and validity as per the Indian Contract Act of 1872 and draft various clauses and conditions of a contract.
6. To understand the concept of valuation & to determine the present fair value of any constructed building at stated time.

Course Outcomes:

On completion of the course, the learners will be able to:

1. **Identify** current unit rates of various construction materials through market survey & also study District Schedule of Rates (DSR)
2. **Prepare** rate analysis of few important Items of work
3. **Estimate** approximate cost of the structures by using various methods & **prepare** detailed estimates of various civil engineering structures, including bar bending schedule, by referring drawings.
4. **Assess** the quantities of earthwork & **construct** mass haul diagrams.
5. **Draft** tender notice & **demonstrate** the significance of the tender as well as contract process.
6. **Evaluate** present fair value of any constructed building at stated time.

Activity Based Tutorials		
Tutorial No.	Tutorial	Tutorial Hours
1	Market Survey for rates of materials & items	02
2	Study of District Schedule of Rates & Prepare rate analysis of few important Items of work	02
3	Prepare approximate estimate of residential building	02
4	Prepare detailed estimate (Measurement sheet & Abstract Sheet) of any two of the following • RCC structure • Road work • Cross drainage work	02
5	Work out Steel quantity by using BBS	02
6	Work out earthwork volume in banking & cutting for a Road section	02
7	Draft Tender Notice for proposed construction Project & study tender documents & Conditions of contract	02
8	Prepare Valuation Report of any Civil Engineering Structure	02

Internal Assessment

Term work: - 25 Marks

The term work shall consist of all tutorials enlisted in the syllabus

The use of quantity survey software and the use of worksheets/databases while solving some of the afore-mentioned tutorial is desirable.

Distribution of marks for Term Work shall be as follows:

Tutorials: 20 Marks Attendance: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks

End Semester Oral Examination: - 25 Marks

Oral examination will be based on Term-work & entire syllabus

Reference Books: -

- 1) Estimating, Costing, Specifications and Valuation: Chakraborty, M., Kolkata.
- 2) Estimating and costing: Datta, B. N., UBS Publications
- 3) Building and Engineering Contracts: Patil, B. S., University Press, Hyderabad.
- 4) Professional Practice: Dr. Roshan H. Namavati

Semester - VII								
Course Code		Course Name						Credits
CEP701		Major Project Part-I						03
Contact Hours			Credits Assigned					
Theory	Practical	Tutorial	Theory		Practical	Tutorial		Total
-	6	-	-		3	-		3
Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Rationale

In the field of Civil Engineering, new problems arise every now and then; but a professional Civil Engineer must know how to precisely identify & state those problems, define the scope & objectives of the probable solution(s), carry out effective review of available literature in the domain of the problem and formulate a systematic methodology to solve the problem. Modern tools and multidisciplinary knowledge are vastly used nowadays for the effective solution of Civil Engineering problem. It is also important to work effectively & ethically as a team and communicate the work done in the form of written reports. The aim of this course is to acquaint the learners with all of the above-mentioned aspects of the Civil Engineering field by inculcating the process of research.

Objectives

1. To acquaint the learners to identify problems
2. To accustom the learners to formulate the scope and objectives
3. To familiarize the learners with the process of review of literature
4. To advice the learners to formulate a methodology
5. To accustom the learners to work as a team
6. To appraise the learners on proper documentation of work

Detailed Syllabus

1. A project group should consist of minimum 3 and maximum of 4 students.
2. The problem statement of the project should preferably be (but not limited to) from the domains of civil engineering.
3. The solutions to the problem may be multidisciplinary i.e., incorporating concepts, tools, techniques etc. of disciplines apart from Civil Engineering.
4. The project work may include:
 - a) Experimental Analysis
 - b) Design of Structures
 - C) Preparation of Working Drawing
 - D) Research on Novel Materials
 - E) Development of Working Models

- F) Studies on Technical and Economic Feasibility
- G) Application of Internet of things (IOT) and Software in field of Civil Engineering.
- H) Application of any other innovative tools and techniques.

Guidelines for Project

- Students should do literature survey/visit industry/analyse current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor
- Students should use multiple literatures and understand the problem.
- Students should attempt solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Guidelines for Assessment of Project I

Project I should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope
5. Breadth and depth of literature survey

Project I should be assessed through a presentation by the student project group to a panel of internal and external examiners appointed by the Head of the Department/Institute of respective Programme.

Contribution to Outcomes

On completion of this course, the students will be able to:

1. Review & comprehend literature in the selected domain
2. Articulate problem statement & identify the objectives
3. Identify existing methods or solutions to solve identified problem
4. Identify modern engineering tools & other resources to solve the problem
5. Formulate methodology to solve the identified problem
6. Effectively communicate their project work by writing reports & presentations

Semester-VIII

Semester VIII

Course Code	Course Name	Credits
CEC801	Construction Management	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	--	03	-	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Practical.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3	-	-	-	100

Rationale

This course is intended to teach students the management skills to be applied during all the stages of Civil Engineering Project. The professional construction engineering practice will be rendered meaningless if service is not offered with a scientific approach and managerial practices. This course deals with the techniques to be applied for planning and scheduling projects, optimizing time-cost and other resources in construction, monitoring & ensuring quality and safety aspects in projects.

Objectives

- 1 To understand the basic functions and construction management.
- 2 To apply scheduling techniques such as CPM & PERT
- 3 To gain knowledge of time-cost optimization & effective utilization of resources on construction sites.
- 4 To understand allocating the resources and project monitoring
- 5 To know about safety and quality aspect of construction works.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Introduction to Construction Management		03
	1.1	Concept and Principles of Management, contribution by eminent personalities like F.W.Taylor, Henry Fayol and Elton Mayo towards growth of management thoughts.	

	1.2	Significance, objectives & functions of construction management	
II	Construction Projects:		03
	2.1	Role and unique features of Construction industry in economic development of country	
	2.2	Construction projects- Classification, Characteristics, Project life cycle	
	2.3	Roles and responsibilities of various agencies associated with a Construction project	
III	Construction project planning & Scheduling:		12
	3.1	Stages of planning in the view of owner / department as well as contractor.	
	3.2	W.B.S, Bar Charts its limitations and its uses, Milestone charts	
	3.3	Network-Terminology, Network Rules, Fulkerson's rule, Precedence network.	
	3.4	C.P.M- Activity & event with their types, activity times, event times, Critical path, forward pass, backward pass, float & its types.	
	3.5	P.E.R.T- Assumption underlying PERT analysis time estimates, slack& its types, probability of completing the project.	
IV	Resources Management & Allocation :		08
	4.1	Material Management- Importance, objectives and functions of material management. Inventory control, A-B-C analysis and E.O.Q.	
	4.2	Human Resource Management- Importance, objectives and functions	
	4.3	Resources Allocation Methods- Resource levelling and Smoothing	
V	Project Monitoring & Cost Control :		08
	5.1	Network Updating- Purpose and frequency of updating.	
	5.2	Time and cost optimization in construction projects - Compression & decompression of network.	
	5.3	Common causes of time over run & cost overrun & Corrective measures.	
VI	Construction Safety, Quality Control & Labour Acts:		05
	6.1	Common causes of accidents on construction sites, costs of accident and precautionary measures to avoid accidents.	
	6.2	Introduction to O.S.H.A. Occupational health hazards & Health Campaign in construction industry.	
	6.3	Concept of Quality and quality control.	
	6.4	Importance of labour acts as applicable to Indian construction labour such as Payment of wages act, Minimum wages act, Workmen's compensation act.	

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Explain & apply the knowledge of management functions like planning, scheduling, Executing & controlling the construction projects.
- 2 Prepare feasible project schedule by using various scheduling techniques.
- 3 Gain knowledge of managing various resources & recommend best method of allocating resources to the project
- 4 Develop optimum relationship between time & cost for construction project
- 5 Implement quality & safety measures on construction sites during execution of Civil Engineering projects.
- 6 Describe the importance of labour acts.

Internal Assessment: 20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination: 80 marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions needs to be solved.

Recommended Books:

- 1 Construction Engineering and Management: S. Seetharaman.
- 2 Construction Planning & Management – Dr. U. K. Shrivastava.
- 3 Construction Projects planning and Management: P. S. Gahlot and Dhir New Age International (p) Publishers
- 4 Construction Project Management: Chitkara K. K. Tata McGraw Hill
- 5 Handbook of Construction Management: P K Joy, Macmillan, India
- 6 Critical Path Methods in Construction Practice: Antill J M & Woodhead R W, Wiley

Reference Books:

- 1 Construction Hazard and Safety Handbook: King & Hudson, Butterworth
- 2 Professional Construction Management: Barrie D.S. & Paulson B C, McGraw Hill
- 3 NPTEL: Civil Engineering-NOC: Principles of construction
<https://nptel.ac.in/courses/105/104/105104161/>

Semester VIII

Course Code	Course Name	Credits
CEDLO8011	Department Level Optional Course-5: Bridge Engineering	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3Hr	-	-	-	100

Rationale

In the age of increase in traffic load and rapid transportation, bridges are very important part of nation's transportation infrastructure associated with the economic growth. Bridges allow for roads and railways to cross over obstacles such as rivers, valleys or other roads etc. Bridges are being built mainly with reinforced concrete, pre-stressed concrete or structural steel depending on various factors such as environment, site conditions, nature of loads and spans etc. The civil engineering profession is much concerned with proper planning, design, construction, maintenance, repairs and rehabilitation of bridges which are of utmost importance.

Objectives

1. Learner will be able to take the appropriate decision in respect of selection of site, type of bridge superstructure, sub structure, bearing, foundation, launching method of girder and construction methods as per conditions.
2. Learner will be able to analyze and design reinforced concrete culverts and pre-stressed concrete bridges using relevant IRCs.
3. Learner will be able to analyze and design lattice girder steel bridge for railway loading using relevant Bridge Rules and IRS code.
4. Learner will be able inspect the bridge and understand general aspects of repairs and rehabilitation.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Introduction of Bridge Engineering		02
	1.1	Types of bridges and their classification, components of a bridge	

	1.2	Selection of suitable site (data required and investigations)	
	1.3	Economic span	
II	IRC loads, their distribution and design of superstructure for roadway bridges using limit state method		20
	2.1	IRC loads: IRC-Class AA and 70R tracked vehicle, Class-A and Class-B train of vehicles	
	2.2	Design of RC culvert	
	2.3	Preliminary design of balanced cantilever bridge	
	2.4	Design of PSC deck slab bridge	
	2.5	Design of PSC I- girder bridge.	
III	IRS loads, analysis and design of steel lattice girder bridge for broad gauge railway		8
	3.1	Various IRS loadings, analysis of steel lattice girder bridge for broad gauge loading	
	3.2	Design guidelines for main components (top chord, bottom chord, diagonal member, end post) of steel lattice girder bridge [Numerical not expected]	
IV	Substructure		4
	4.1	Types of foundations and their choices, well foundation, pile foundation	
	4.2	Types of piers & abutments and their shapes, wing walls	
	4.3	Need of bearing, types and suitability	
V	Erection of girder and construction methods		2
	5.1	Various methods of erection of bridge girders	
	5.2	Cantilever method of construction of bridge	
VI	Inspection and repairs of bridges		3
	6.1	Categories of bridge inspection and instruments	
	6.2	General aspects of repairs, retrofitting and rehabilitation	

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Choose the suitable type of bridge according to site condition.
- 2 Design RC Culvert and RC balanced cantilever bridge using relevant IRCs.
- 3 Design prestressed concrete deck slab bridge and I-girder bridge using relevant IRCs.
- 4 Design steel lattice girder bridge using IRS loading.
- 5 Choose different bearings, foundations, piers and abutments based on their suitability.
- 6 Choose method of erection of bridge superstructure and repair techniques of existing bridges.

Site Visit/ Field Visit:

The learner shall visit an under construction prestressed concrete bridge or steel lattice girder bridge site and prepare a detailed report on the same.

20 Marks

Internal Assessment Examination

Consisting of two compulsory Class Tests. First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.
- 5 IRC: 6, IRC: 112 and IS: 1343 are allowed in the examination.

Recommended Books:

- 1 Design of Bridges: *Raju N. K.*, Oxford and IBH
- 2 Bridge Engineering: *Ponnuswamy S.*, Tata Mc Graw Hill
- 3 Design of Bridge Superstructures: *T.R. Jagdeesh* and *M.A. Jayaram*, Prentice Hall India Private Ltd., New Delhi
- 4 Comprehensive Design of Steel Structures: *Dr. B C Punmia*, *Ashok Kumar Jain* and *Arun Kumar Jain*; Laxmi Publications (P) Limited

IRC Codes:

IRC: 5- 2015, IRC: 6- 2017, IRC: 78-2014, IRC: 83-(Part-I)-2015, IRC: 83-(Part-II)-2018, IRC: 83-(Part – III)-2018, IRC: 112-2020, IRC:123-2017, IRC SOR17-1996, IRC SOR18-1996, IRC SP13-2004, IRC SP37-2010, IRC SP40-1993, IRC SP54-2000, IRC: SP105-2015

IRS Codes:

Bridge Rules: Rules specifying the loads for design of super-structure and sub-structure of bridges and for assessment of the strength of existing bridges -2014

Indian railway standard code of practice for the design of steel or wrought iron bridges carrying rail, road or pedestrian traffic (steel bridge code) -2017

Reference Books:

- 1 Concrete Bridge Practice: *Raina V. K.*, Tata Mc Graw Hill
- 2 Essentials of Bridge Engineering: *Victor D.J.*, Oxford and IBH
- 3 Bridge Engineering Handbook: *Chen W. F. and Duan L.*, CRC Press, 2000
- 4 Bridge Bearings and Expansion Joints: *David Lee*, E & FN Spon

Semester VIII

Course Code	Course Name	Credits
CEDLO8012	Department Level Optional Course-5: Design of Hydraulic Structures	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--		03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam (Hours)	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3	--	--	---	100

Rationale

Hydraulic structures are the structures designed to retain, convey, control, regulate, mix and dissipate the energy of water. Such structures are constructed in all domains of water engineering; primary domains being water quantity management (water supply, irrigation, hydro power, flood control, drainage, navigation, socio-economic and recreational use), water-quality management and various transportation aspects. While the course emphasizes the “WHY” aspect; e.g., design of multi-purpose reservoirs and canal works, it also examines the “HOW” aspect of hydraulic structures. It is only through this mindful approach that the engineer can determine the advantages of a proposed design for a specific application.

Objectives

1	To understand the reservoir and planning of reservoir, different zones, capacity and sedimentation control.
2	To convey the knowledge on the various types of Dams, utility and adaptability of various dams.
3	To develop understanding of the various causes of failure, design criteria and stability analysis of Gravity & Embankment dam.
4	To understand Spillways and Energy dissipators, their applicability.
5	To impart knowledge of canal headworks, canal regulation works and cross drainage works

Detailed Syllabus

Module	Course Module / Contents	Periods
I	Reservoir Planning and Management:	5
	Purpose of reservoir, classification of Reservoir, site selection, Investigation works for reservoir, storage zones storage capacity of reservoir, Yield and capacity of reservoir, mass inflow curve and demand curve, Determination of reservoir capacity, determination of safe yield, reservoir losses, reservoir sedimentation, sediment control, Multipurpose reservoirs, Flood Routing and its methods.	
II	Gravity Dams:	10
	Various forces acting on gravity dam, Load combinations for design, Stability requirements & modes of failure, principal and shear stress, Profile of dam- elementary and practical profile, low and high gravity dam, Limiting height of gravity dam, High and Low gravity dam, Design of gravity dams, Galleries, Joints, Keys, Water seals, crack control in concrete dams.	
III	Arch and Buttress Dams:	4
	Types of arch dams, forces acting on arch dam, design of arch dams, types of buttress dams.	
IV	Earth and Rock Fill Dams:	9
	Types of earth dams, causes of failures of earth dams, design criteria, section of earth dam, downstream drainage system, seepage analysis, phreatic line, Stability analysis, stability of d/s slope during steady seepage, stability of u/s slope during sudden drawdown, stability of u/s and d/s slopes during construction, slope protection, seepage control measures, design considerations in earthquake regions, types of rock fill dams.	
V	Spillways and Flood Control Works:	6
	Introduction, Necessity of spillways, location of spillway, design consideration of main spillway, Classification of spillways, straight drop spillway, design principles of ogee spillway, Chute spillway, Side channel spillway, conduit spillway, Siphon spillway and shaft spillway, energy dissipation below spillways, location of hydraulic jump and its	

	characteristics, design of bucket type energy dissipator and stilling basin,. Crest gates, types, advantages, design of radial gate, outlet works.	
VI	Miscellaneous Topics:	
	Diversion head works-Component parts, functions, weirs and barrages, Bligh's Creep theory, Lane's weighted theory, Khosla's Theory. Canal regulation works - classification, Sarda type fall, Head regulators and Cross regulators, Canal escape. Cross Drainage Works-Types, classification of aqueducts and syphon aqueducts	5

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Explain the Reservoir planning, storage capacity, Sedimentation & Reservoir losses.
- 2 Carry out the stability analysis of Gravity & Earth Dam.
- 3 Explain the causes of failure of various dams & their design criteria.
- 4 Design an ogee spillway.
- 5 Suggest suitable energy dissipation measures.
- 6 Describe the various minor irrigation structures such as Weirs & barrages, Canal Regulators and Cross-drainage works.

Internal Assessment_20 Marks

Consisting Two Compulsory Class Tests - First test of 20 marks based on approximately 40% of contents and second test of 20 marks based on remaining contents (approximately 40% but excluding contents covered in Test I). Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

End Semester Examination_80 Marks

Weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

- 1) Question paper will comprise of a total six questions, each carrying 20 marks.
- 2) Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3) Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4) Only Four questions need to be solved.

Recommended Books:

1. Irrigation and Water Power Engineering: B.C. Punmia, Pande B.B.Lal, A.K Jain. Laxmi Publications Pvt, Ltd. New Delhi.
2. Irrigation Engineering and Hydraulic Structures: S.K. Ukarande, Ane Books Pvt. Ltd. ISBN-9789383656899.
3. Irrigation Water Resources and Water Power Engineering: P.N. Modi, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
4. Irrigation Engineering and Hydraulics Structures: S. K. Garg, Khanna Publishers. Delhi.
5. Design of Irrigation Structures: S. K. Sharma, S. Chand and Co.

Reference Books:

1. Theory and Design of Irrigation Structures: R. S. Varshney and R, C. Gupta, Nem Chand
2. Engineering for Dams, Vol. I to III: Crager, Justin and Hinds, John Wiley
3. Design of Small Dams: USBR.
4. Hydro Power Structures: R. S. Varshney, Nem Chand and Bross.
5. Concrete Dams: R. S. Varshney, Oxford and IBH Publishing Co.

Semester VII								
Course Code			Course Name				Credits	
CEDLO8013			Department Level Optional Course-5: Construction Safety				3	
Contact Hours				Credits Assigned				
Theory		Practical	Tutorial	Theory	Practical	Tutorial	Total	
3		-	-	3	-	-	3	
Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Practical	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs	-	-	-	100
Rationale								
The primary goal of this course is to have students learn that a "culture" of safety needs to be developed within companies for a safety program to be effective. This course is more about managing the safety process than the details involved in the specific construction activities. Students in this course will be provided an understanding of safe working practices, various training that are required to be undergone by employees to ensure safe working environment on construction sites, record keeping and maintenance of records, compliance with OSHA worker safety, codes and environmental safety laws, inspection procedures, and penalties for lack of conformance to safety laws. Students will also learn procedures for recognizing hazards, CPR, site safety meetings and accident investigations.								
Objectives								
1	Plan to comply with safety documentation/procedures and legal requirements							
2	Differentiate OSHA requirements for different work activities							
3	Design Safety and Emergency response plans							
4	Analyse the cost of Accidents							
5	Design an effective company safety culture manual							
6	Prepare complete corporate safety plan and site-specific safety plan containing hazard analysis of actual construction projects.							

Detailed Syllabus			
Module	Course Module / Contents		Periods
I	Construction Safety Management:		04
	1.1	Role of top management, Duties & responsibilities of various officers on site, Responsibilities of general employees	
	1.2	Safety committee. Role of safety officer	
	1.3	General OSHA Requirements, Safety training, Safety campaign	
II	Safety in construction operations and emergency response		06

Consisting 2 Compulsory Class Tests - 1 st test based on approximately 40% of contents and 2 nd test based on remaining contents (approximately 40% but excluding contents covered in Test I)	
End Semester Examination	80 Marks
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.	
1	Question paper will comprise of total six questions, each carrying 20 marks.
2	Question 1 will be compulsory and should cover maximum contents of the curriculum.
3	Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4	Only Four questions need to be solved.
Recommended Books:	
1	Construction Safety and Health (2nd ed), David L. Goetsch, Publish by Pearson ISBN-13: 978-0-13-237469-9, ISBN-10: 0-13-237469-2
2	Safety Management, Girmaldi and Simonds, AITBS Publishers, New Delhi
3	Construction Safety, Jimmy W. Hinze , Prentice Hall Inc.,
4	Construction Safety and Health Management, Richard J. Coble, Jimmie Hinze and Theo C. Haupt, , Prentice Hall Inc., 2001.
5	Construction Safety, R.K. Mishra, AITBS Publishers, New Delhi
6	Safety Management in Construction (Principles and Practice), S.K. Bhattacharjee, Khanna Publishers, New Delhi
7	Safety, Occupational Health And Environmental Management In Construction, S. C. Sharma and Vineet Kumar,
8	Construction Safety (English), by D.S.S.Ganguly and C.S.Changeriya, Chetan Publication; 2017 th edition, ISBN-10 : 9386953293,ISBN-13 : 978-9386953292
9	Construction Safety Handbook - Davis V.S Thomasin K, Thomas Telford, London
Reference Books:	
1	Construction Safety Manual published by National Safety Commission of India
2	Safety Management in Construction Industry”- A manual for project managers- NICMAR, Pune
3	Construction Safety Handbook - Davis V.S Thomasin K, Thomas Telford, London
4	IS standards for safety in construction - Bureau of Indian Standards
5	OSHA Standards (CFR 1926) at www.osha.gov/readingroom.html

Semester VIII

Course Code	Course Name	Credits
CEDLO8014	Department Level Optional Course-5: Pavement Design	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	-	-	-	100

Rationale

The pavements are classified according to mode of transportation (highway and airways) and structural behaviour (flexible and rigid). The design of any pavement warrants the proper analysis thereof. The course deals with the various methods of the analyses and design of pavements.

Objectives

- 1 To study the different types of pavements depending upon the mode of transportation, factors affecting pavement design, and methods.
- 2 To understand the concept of analysis of stress, strain and deflection in pavement.
- 3 To enable the students to understand and analyse the mechanics related to flexible pavements as applicable for highways.
- 4 To study the various types of structural responses (stresses and deformations) inducing the pavements due to wheel load and other climatic variations. To enable the students to understand and analyses the concrete pavements as applicable for highways.
- 5 To enable the students to understand and analyse the mechanics related to flexible and concrete pavements as applicable for airports.
- 6 Evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements and introduce pavement management system

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Introduction		04
	1.1	Classification of Pavement, Pavement structure and functional attributes, factors affecting pavement design.	
	1.2	Types of wheel loads for highways and airports, development of design method for highway and airport pavements	
II	Stresses in Pavement		06
	2.1	Stresses in flexible pavements, 1-layer, 2-layer, 3-layers theories, EWLF,ESWL	
	2.2	Stresses in Rigid pavement: load and temperature stresses, combined stresses.	
III	Flexible Pavement Design		08
	3.1	Empirical methods using no soil strength criteria, empirical method based no soil strength criteria: CBR method as specified by IRC-37 -1970, 1984, 2001, 2012, 2018.	
	3.2	Road note 29 methods, AASHTO method, Asphalt institute method. Fatigue and rutting as a failure criterion.	
	3.3	Introduction to use of software for flexible pavement design.	
IV	Rigid Pavement Design		08
	4.1	Load and temperature stresses in rigid pavements Westergaard's, Bradburry's and Picket's concepts	
	4.2	Design steps as per IRC-58-2012,2015 method	
	4.3	Design of joints in rigid pavements	
	4.4	Introduction to use of software for rigid pavement design	
V	Design of Airport Pavements		08
	5.1	Factors affecting, types of wheel loads , aircraft loading, gear configuration and tyre pressure , development of design method	
	5.2	Design Methods: Corps of Engineer's method, FAA method CDOT method, Asphalt institute method. PCA methods	
	5.3	Joints and reinforcement requirement.	
VI	Design of Overlay		05
	6.1	Design aspects of flexible and rigid overlays design of overlays (IRC-81-1997)	
	6.2	Introduction to pavement management systems: Components of pavement management systems	

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Explain the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of pavements.
- 2 Describe the applications of the analysis in the design of pavements using different methods of pavement design.
- 3 Explain of the design of flexible pavement.
- 4 Describe the design of Rigid pavement.
- 5 Explain the design of airfield pavements and apply this knowledge in the field
- 6 Evaluate the different types of distresses occurring in the existing pavements and carry out the structural and functional evaluation of the pavements. Understand the pavement management system.

Internal Assessment

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Principles and Practice of Highway Engineering: *L.R.Kadiyali*, Khanna publications.
- 2 Highway Engineering: *Khanna S.K. and Justo C.E.G.* Nem Chand (Revised 10th Edition, 2014)
- 3 Principles, Practice and Design of Highway Engineering (Including Airport Pavements): *Sharma, S.K.*, S. Chand Technical Publications (3rd Revised Edition, 2013)
- 4 Pavement Design: *Yoder and Witzech*, McGraw-Hill, 1982.

Reference Books:

- 1 Rajib Mallick & Tahar El-Korchi, *Pavement Engineering: Principles and Practice*, CRC Press , 2nd Edition, 2013
- 2 A. T. Papagiannakis, Eyad A Masad, *Pavement Design and Materials*, John Willey and Sons , 1st Edition 2008
- 3 Relevant Latest IRC, ASTM, AASHTO and other Codes, Manuals and Specifications
- 4 R Srinivasa Kumar, *Pavement Design* , University Press.
- 5 Pavement Analysis and Design: *Yang H. Huang*, Prentice Hall, New Jersey, 1993

Semester VIII

Course Code	Course Name	Credits
CEDLO8015	Department Optional Course 5: Industrial Waste Treatment	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

Industrial wastewater is much more polluted than the domestic wastewater and hence has to be treated with the efficient choice of treatment units by preventing pollution of natural streams and rivers. Wastewater treatments may not suffice only with primary treatments until they are modified and supplemented by additional techniques because of toxic chemicals. Industries are therefore generally prevented by legal aspects, from discharging their untreated effluents. It becomes mandatory for industries to treat their wastewater in their individual treatment plant or common effluent treatment plant before discharging their waste on land, lake, river, municipal sewer, streams as the case may be.

Objectives

1. To enable the students to understand quality, characteristics, toxicity of industrial wastewater and its effects on streams.
2. To enable the students to understand the impact of industrial wastewater on natural streams.
3. To enable the students to understand waste minimization techniques for industrial wastewater.
4. To enable the students to understand the necessary knowledge and concepts of biological treatment and advanced/emerging techniques.
5. To enable the students to understand various industrial manufacturing process, effluents and treatments.
6. To enable the students to understand legislative framework for the remediation of industrial wastewater through environmental audit, environmental impact assessment and common effluent treatment plant.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Introduction to industrial waste and treatments: Sources and types of industrial waste-water, Effects of industrial waste-water on streams and waste-water treatment plants. Population equivalence, generation rates, characterization, important contaminants of concern from industries. Toxicity and Bioassay tests. Regulation for protection of streams. BOD Numericals.		06
II	Stream Protection Measures: Stream and effluent standards, stream sampling, stream sanitation, Procedures for improving stream water quality, zones of pollution, oxygen sag curve, Streeter Phelps Equation and numerical.		06
III	Waste minimization:		06
	3.1	Minimizing effects of industrial waste water: Volume reduction and Strength reduction	
	3.2	Equalization, Neutralization, Proportioning, Precipitation, Coagulation and flocculation. Flotation - Oil separation and Emulsion breaking.	
IV	Waste-water treatments for industries		06
	4.1	Biological treatments: Aerobic and Anaerobic biological treatment methods (Ponds, lagoons, UASB, RBC). Sludge dewatering techniques- Filter Press, Vacuum Filtration, Sludge thickening, Membrane filtration and Centrifuge.	
	4.2	Advanced treatments: Need for advance technologies, Automated Chemostat Treatment (ACT) Soil Biotechnology (SBT) Reed Bed Technology (RBT) Ozonation	
V	Industries and waste-water management: Raw material, Manufacturing process and flow-sheets, sources of effluents, characteristics, ETP, byproduct recovery for following industries: ● Sugar ● Distillery ● Tannery		10

	● Dairy ● Paper and Pulp ● Metal Processing Industry (Electroplating)		
VI	Legal Aspects, Environment Management Tools and Common Treatment Facility for industries		05
	6.1	Environmental Impact Assessment, Case Study.	
	6.2	Environmental Audit for industries.	
	6.3	Common Effluent Treatment Plants (CETPs): Flow chart, Location, Need, Operation & Maintenance Problems and Economical aspects. Case study.	

Contribution to Outcome

Having completed this course, the students shall acquire the knowledge of biological treatment and will be able to decide and select precise treatment for particular waste. The students shall be able to determine and design the treatment facilities and assess the guidelines for disposing of waste. They shall be able to formulate approaches to treat waste water in the most effective manner for contamination removal.

After the completion of the course the learner should be able to:

1. Explain the impact of industrial wastewater characteristics on natural streams.
2. Analyze various stream protections measures to protect the natural streams.
3. Summarize waste minimization techniques for industrial wastewater.
4. Relate biological treatment concept and summarize various treatments along with advance technologies.
5. Describe waste water generated during manufacturing process and decide the suitable treatment for effluents.
6. Evaluate legislative framework for the remediation of industrial wastewater through environmental audit, environmental impact assessment and common effluent treatment plant.

Internal Assessment:

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

End Semester Examination:

80 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of a total six questions, each carrying 20 marks.

- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature
- 4 Only Four questions need to be solved.

Recommended Books:

1. Industrial Pollution Control by Eckenfedlar W.W, 2017
2. Wastewater Engineering Treatment, Disposal, Refuse: Metcalf and Eddy, T.M.H. Edition, New Delhi, 1995.
3. Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: S. K. Garg, Khanna Publishers New Delhi.
4. Water supply and sanitary Engineering: Hussain S. K., Oxford and IBH Publication, New Delhi.
5. Wastewater Treatment for Pollution Control and Reuse Hardcover – 1 July 2017, Soli. J Arceivala , Shyam. R Asolekar.
6. Environmental Engineering: B. C. Punmia, Laxmi Publications, New Delhi.
7. Water Supply and Sewerage: E.W. Steel.
8. Introduction to Environmental Engineering, Vesilind, PWS Publishing Company 2000.
9. Introduction to Environmental Engineering: P. Aarne Vesilind, Susan M. Morgan, Thompson.
10. Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian.
11. Basic Principles of Wastewater Treatment Book ,Marcos Von Sperling
12. Industrial Waste Water Treatment Book, A. D. Patwardhan
13. Waste Water Treatment , M.N. Rao and Dutta

Reference Books:

- 1) Manual on Wastewater Treatment 3rd Ed. Pub: CPH and Env. Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1991.
- 2) CPHEEO Manual on Sewage and Treatment.
- 3) Relevant Indian standard specifications and BIS publications.
- 4) Handbook of Water and Wastewater Treatment Plant Operations Book,y Frank R. Spellman

Semester VIII		
Subject Code	Subject Name	Credits
CEDLO8016	Department Level Optional Course-5: Soil Dynamics	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term Work/ Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Rationale

In basic geotechnical engineering course normally various static loads are considered in the theories and analysis of soil. But practically many geotechnical applications require the knowledge of the behavior, properties and response of soil as a material which is subjected to various types of dynamic or cyclic time-dependent loadings. Some of the structures which are subjected to dynamic loadings are machine foundations, shallow and deep foundations, retaining structures, slopes, subgrade soil below railway, pavement, runway etc. This course provides the fundamental theoretical and computational aspects of dynamics for some important geotechnical problems and structures.

Objectives

1. To study fundamental concepts of vibrations, degrees of freedom and damping systems.
2. To study phenomena like liquefaction and their effects.
3. To study principals of machine foundation design and dynamic earth pressure theories on Retaining wall.
4. To learn test methods of evaluating dynamic properties of soil.
5. To know the earth pressure on retaining walls.

Detailed Syllabus		
Module	Sub- Modules/Contents	Hrs
I.	Introduction to Soil Dynamics	04
	1.1 Introduction to vibration (simple harmonic motion), Types of waves 1.2 Introduction to the concept of degree of freedom 1.3 Introduction to dynamic soil properties (IS4249) 1.4 Scope and objective, Nature and types of dynamic loading, Importance of soil dynamics.	
II.	Dynamic approach in different components	05
	2.1 Wave propagation in elastic rods, in an elastic finite medium and in semi-elastic half space 2.2 Wave generated by surface footing	
III.	Liquefaction of Soil	08
	3.1 Introduction to liquefaction of soils and its basic terminologies, criterion and factors affecting liquefaction of soil. 3.2 Liquefaction studies in triaxial shear, field studies on liquefaction 3.3 Evaluation of liquefaction potential using analytical method and SPT.	
IV.	Machine Foundation	06
	4.1 Principles of machine foundation design, criteria for satisfactory machine foundation, degree of freedom of a block foundation, analysis of vertical and sliding vibration of a machine foundation 4.2 Practical design considerations and code provisions.	
V.	Dynamic behavior of Machine Foundation	05
	5.1 Mass of soil participating in vibration. 5.2 Vibration isolation and screening methods, improvement of distressed machine foundation.	
VI.	Dynamic behavior of Retaining Wall	11
	6.1 Field and laboratory tests for evaluation of dynamic properties of soil under vertical vibration coefficient of elastic uniform shear, spring constant damping modulus of elasticity typical values of soils. 6.2 Basics of dynamic earth pressure on retaining walls conventional gravity type, reinforced soils, distribution of pressure, and point of application of the resultant, simple examples.	
Total teaching Hours		39

Course Outcome

On successful completion of the course, the students are expected to:

1. Demonstrate the knowledge of concepts, principles, and applications of soil response under dynamic loading.
2. Develop an ability to design with reference to code provisions and solve the practical soil problems subjected to vibrations.
3. Able to explain the concept of Liquefaction Potential of different types of soil
4. Provide an impetus to new developments in related dynamic topics.

5. Carryout field tests on soil to know the dynamic properties of soil.
6. Calculate the dynamic earth pressure on retaining walls.

Internal Assessment:

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents And second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

Theory Examination:-

- Question paper will comprise of **six** questions: each carrying 20marks.
- The **first** question will be **compulsory** which will have the short questions covering the entire syllabus.
- The remaining five questions will be based on all the modules of Entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub- module and contents thereof.
- There can be an internal choice in various sub-questions / questions to accommodate the Questions on all the topics /sub-topics.
- The students will have to attempt any **three** questions out of remaining **five** Questions.
- Total **four** questions need to be attempted.

Recommended books:

1. Soil Dynamics: *Shamsher Prakash*, McGraw-Hill book company
2. Principles of Soil Dynamics: *Braja, M.Das*, PWS-Kent Publishing Company
3. Dynamics of Bases and Foundations: *Barkan, D.D.*, McGraw- Hill Book company
4. Geotechnical Earthquake Engineering", StevenL.Kramer ,PrenticeHallInc.
5. Vibrations of Soils and Foundations", E.E.Richartetal ,PrenticeHallInc.
6. Relevant IS codes

Semester VII

Course Code	Course Name	Credits
CEDLO8021	Department Optional Course 6: Repairs, Rehabilitation and Retrofitting of Structures	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

Structures need strengthening and repairs due to variety of reasons. Now a days different materials, techniques and machineries are used to improve the structures and prolong their serviceable life. A structure needs regular maintenance to perform satisfactorily during its lifetime. This subject deals with damage assessment, preparing a strengthening strategy of RCC , steel structures, Seismic Retrofitting and maintenance of heritage structures.

Objectives

1. To understand the concept of Repair of repair and its need.
2. To understand various causes of deterioration of concrete structure and Distresses monitoring techniques.
3. To understand various materials of repairs and their properties.
4. To understand various methods of repairs of concrete structure.
5. To understand various methods of repairs of steel structure.
6. To understand seismic retrofitting and maintenance of heritage structures.

Detailed Syllabus

Module	Contents		Periods
1	Introduction		03
	1.1	Need for repair, rehabilitation and maintenance of structure. Repair Management. Sustainable development.	
	1.2	Maintenance and it's importance, life cycle cost of structure	
	1.3	Heritage structure and need for their Rehabilitation	
2	Damage Assessment		08
	2.1	Causes of deterioration of concrete: Physical , Chemical and Mechanical causes.	
	2.2	Distresses monitoring, Visual inspection, Non Destructive Testing using Rebound hammer, Ultra sonic pulse velocity, Semi destructive testing, Probe test, Pull out test, Chloride penetration test, Carbonation, Carbonation depth testing, Corrosion activity measurement.	
	2.3	Types of cracks: Diagonal Cracks, Horizontal Cracks, Splitting Cracks, Corrosion Cracks, Plastic shrinkage cracks, thermal cracks	
	2.4	Crack Measurement techniques: Steel Ruler, Magnified Graticule , Plastic Tell Tale Glass Tell Tale Brass Screws and Caliper Displacement Transducer	
3	Repair of Concrete Structures		06
	3.1	Methods of crack repairs: Epoxy injection, Routing and Sealing of Cracks, Stitching Prestressing steel Drilling and Plugging Method Gravity Filling Method	
	3.2	Repair Materials: Essential parameters for repair materials.. Materials for repair: Materials for Surface Preparation, Chemical Rust removers for corroded reinforcement, Passivators for reinforcement protection, Bonding Agents, Structural Repair Materials, Non-structural Repair Materials, Injection grouts, Joint sealants, Surface coatings for protection of RCC. Premixed Cement concrete/mortars, Polymers/latex modified cement mortars, Epoxy resins	
	3.3	Corrosion repair methods: Cathodic Protection, Chloride Removal	
4	Rehabilitation and Retrofitting Methods		10
	4.1	Repair Stages: Concrete Removal and Surface Preparation, Fixing formwork, Bonding / passivating coat and repair application.	
	4.2	Repair Methods: Repairs using mortars/modified mortars, Epoxy based material repairs, Shotcrete, Ferro-	

		cement, Plate bonding, RCC Jacketing Propping and Supporting, Fibre Wrap Technique.	
	4.3	Foundation Rehabilitation Methods: Shoring, Raking shores, Flying shores, Dead shores. Underpinning. Slab jacking.	
5	Repair of steel structures		06
	5.1	Types and causes for deterioration - Preventive measures - Repair procedure - Brittle fracture - Lamellar tearing - Defects in welded joints -	
	5.2	Design and fabrication errors - Distress during erection - Causes and remedies	
	5.3	Repair methods for structures.	
6	Seismic Retrofitting and Maintenance of Heritage Structures		06
	6.1	Earthquake damages of buildings, their retrofitting and restoration. Effects of earthquakes.	
	6.2	Methods of seismic retrofitting, restoration of buildings Special care in repair and rehabilitation of heritage structures.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

1. Describe the concept of repair and its need.
2. Classify various causes of deterioration of concrete structure and Distresses monitoring techniques.
3. Classify various materials of repairs and their properties.
4. Explain various methods of repairs of concrete structure.
5. Describe various methods of repairs of steel structure.
6. Explain seismic retrofitting and maintenance of heritage structures.

Internal Assessment:

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- Question paper will comprise of **six** questions: each carrying 20marks.
- The **first** question will be **compulsory** which will have the short questions covering the entire syllabus.
- The remaining five questions will be based on all the modules of Entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub- module and contents thereof.
- There can be an internal choice in various sub-questions / questions to accommodate the Questions on all the topics /sub-topics.
- The students will have to attempt any **three** questions out of remaining **five** Questions.
- Total **four** questions need to be attempted.

Recommended Books:

1. CPWD Handbook on Repair and Rehabilitation of RCC buildings, Govt of India Press, New Delhi
2. Santhakumar A.R., "Concrete Technology" Oxford University Press, 2007, New Delhi
3. Bhattacharjee J, Concrete Structures Repair Rehabilitation and Retrofitting- 2019 , CBS Publishers & Distributors Pvt. Ltd.

Reference Books:

1. Raikar, R.N., "Learning from failures - Deficiencies in Design, Construction and Service" R and D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.
2. Maintenance, Repair & Rehabilitation and Minor Works of Buildings
P.C.Varghese, PHI Publications
3. P.K.Guha , Maintenance & Repairs of Buildings, New Central Book Agency (P) Limited,
4. R.Dodge , Concrete structures Concrete Structures Protection Repair and Rehabilitation, woodson

Semester VIII

Course Code	Course Name	Credits
CEDLO8022	Department Optional Course 6: Physico - Chemical Treatment of Water and Waste Water	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

This course introduces the principles and physico-chemical methods to control water and wastewater pollution. The aim of the course is to give a more fundamental and theoretical understanding of the specific unit processes, providing a better understanding of the principles of how they function and the degree of treatment that can be achieved. Students should be conversant with the sedimentation, coagulation, filtration, disinfection, advanced physico-chemical processes of water and wastewater. They should be conversant with de-watering and disposal of sludge.

Objectives

1. To study the impact of water and waste-water treatment on the environment.
2. To develop the rational approach towards the design of preliminary treatments.
3. To design primary treatment units.
4. To Explain and apply chemical unit techniques.
5. To impart knowledge about the advanced treatment for water and waste-water.
6. To study sludge de-watering & disposal techniques.

Detailed Syllabus

Module	Course Module / Contents	Periods
I	Quality, Quantity of Water and Waste-water	6
	Characteristics of water and waste-water, conventional water and waste-water treatment, Sampling and analysis, Health and environmental concerns, Components of waste water flows, sources, strategies for reducing interior water use and waste water flow rates, waste water reclamation and reuse	
II	Preliminary Treatment of Water and Waste-water	6
	Screens: significance, Classification of screens, Design for head loss, Grit chambers: Gravity settling, stoke's law, Classification and Design Skimming Tank design and flotation	
III	Primary Treatment of Water and Waste-water	8
	Sedimentation: Significance, Types of sedimentation tanks, Zones of settling, Design parameters, Design of sedimentation tank, Tube settlers Filtration: Mechanisms of filtration, hydraulics of filtration, different types of filters, filter clogging, filter washing, Design criteria of Rapid sand filter	
IV	Chemical units-Techniques:	6
	Role of chemical unit processes in water and waste water treatment, Coagulation: Fundamentals, coagulant aids, polyelectrolytes, Design of flash mixer, power requirement Flocculation: Types of flocculation and flocculators, Design of flocculator, power requirement	
V	Advanced Physico-chemical Processes:	08
	Softening, methods of softening, Chemical precipitation, Desalination, solar distillation, Reverse osmosis, Electrolysis Disinfection, Disinfection using chlorine and UV. Estimation of Chlorine doses, Use of various forms of chlorine Removal of heavy metals, neutralization, Chemical oxidation of BOD and COD, Removal of colour, Gas stripping, Adsorption and Ion Exchange, Reverse osmosis, Membrane filtration, Activated carbon treatment	
VI	Sludge De-watering and Disposal	05
	Sources of sludge, Estimation of bulk density of sludge, Principles of dewatering, Methods and suitability, thickening of sludge, Chemical conditioning, Elutriation of sludge, Vacuum and pressure filtration, sludge drying beds, Design of sludge drying beds	

Contribution to Outcome

After the completion of the course the learner should be able to:

1. Explain the quality, quantity and treatment of water and waste-water.
2. Design preliminary units for treatment of water and waste-water
3. Evaluate the removal efficiencies of physico-chemical treatment units.
4. Identify optimized dose of chemical coagulation as well as disinfecting agents.
5. Apply advanced physico-chemical processes to water and waste-water.
6. Administer sludge de-watering and disposal process

Internal Assessment:

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I) Average marks scored in the above two tests will be considered for final assignment of marks which will be out of 20.

End Semester Examination

**80
Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of a total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature
- 4 Only Four questions need to be solved.

Recommended Books:

1. Wastewater Engineering Treatment, Disposal, Refuse: Metcalf and Eddy, T.M.H. Edition
2. Water Supply Engineering: S. K. Garg, Khanna Publication.
3. Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: S. K. Garg, Khanna Publishers.
4. Water supply and sanitary Engineering: Hussain S. K., Oxford and IBH Publication, New Delhi.
5. Industrial Pollution Control by Eckenfedlar W.W
6. Wastewater Treatment for Pollution Control and Reuse Hardcover – by Soli. J Arceivala (Author), Shyam. R Asolekar (Author)
7. Environmental Engineering: B. C. Punmia, Laxmi Publications, New Delhi.
8. Water Supply and Sewerage: E.W. Steel.
9. Introduction to Environmental Engineering, Vesilind, PWS Publishing Company 2000.
10. Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian.
11. Basic Principles of Wastewater Treatment Book by Marcos Von Sperling
12. Industrial Waste Water Treatment Book by A. D. Patwardhan

13. Environmental Engineering: Peavy,H.S., RoweD.R.,
14. CPHEEO Manual on Water Supply and Treatment.
15. CPHEEO Manual on Sewage and Treatment

Semester VIII

Course Code	Course Name	Credits
CEDLO8023	Department Level Optional Course-6: Transportation System Engineering	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Rationale

Transportation contributes to the economical, industrial, social cultural development of any country. The adequacy of Transportation system of a country indicates its economic social development. Three basic modes of transportation include land, water and air. The land mode further includes highways and railways. This course is developed so as to impart the basic principles behind Railway Engineering, Airport Engineering, Water Transportation Engineering, Public Transportation system in respect of various types of materials used, function of component parts and planning principles.

Objectives

- 1 To enable the students to study the various elements of Transportation system in the country, NUTP and its Environmental consideration.
- 2 To study, plan and design different elements of airports and understand aircraft movement controls.
- 3 To explain and design various geometric elements of railways and study the elements of modern rails.
- 4 To Explain different components of water transport such as Ports, Harbors and Docks.
- 5 To study and Explain planning elements of public transport systems.
- 6 To Explain different components of bridges, planning of bridges and analyzing different hydrological elements of bridge.

Detailed Syllabus

Module	Course Module / Contents		Periods
I	Introduction to Transportation System		05
	1.1	Role of transportation system in development of country, Different modes of transportation; their merits and demerits, present scenario of each mode in India. Different modes of Public Transportation modes available in Mumbai and Suburban areas with advantages and disadvantages of each.	
	1.2	Urban Transport: National Urban Transport Policy, Sustainable Transportation, Transit Oriented Development.	
	1.3	Environmental Guidelines for Transportation Infrastructure Projects: Environmental Impact Assessment, Identification of Impacts, Measures for offsetting adverse impacts.	
II	Air Transportation System		10
	2.1	Introduction: Aircraft: Types and components Airport: Site selection, classification, obstruction, zones and zoning laws, Environmental impacts and guidelines for Airport projects	
	2.2	Airport components: Requirements and functions of each Terminal building: Layout and planning, gate positions and gate capacity, blast consideration Apron and holding apron Taxiway: Design Runway: Configuration, orientation, wind rose diagram, basic runway length and corrections to runway length, Aircraft parking and hangars Airport drainage: Requirements and types	
	2.3	Aircraft movement control: Lighting and marking of runway, taxiway and other areas Air traffic control aids, en-route aids and landing aids	
	2.4	Planning of Heliports: Characteristics of Helicopter, Selection of site, Size of landing area, Obstruction clearance requirements, Marking and Lighting of Heliports.	
III	Rail Transportation System		08
	3.1	Introduction: Alignment of Railway lines, Engineering Surveys for new railway lines. Introduction to Railway Track Components: Requirements and functions of each	
	3.2	Geometrics- Gradient: Types Curves: Widening on curves, cant and cant deficiency Turnout: Components and design	
	3.3	Yards: Types and functions, Signaling- classifications,	

		interlocking of signals and points	
	3.4	Modern Rails: Characteristics of MAGLEV, Metro rails and mono rails, modernization of track and railway station, high speed trains (Bullet trains) and high-speed tracks	
IV	Water Transportation System		04
	4.1	Harbour: Classification, functions and requirements Harbour Infrastructures: Types of breakwaters, jetty, dock fenders, piers, wharves, dolphin, mooring accessories	
	4.2	Docks: Repair facilities, wet docks, lift docks, dry docks, gates for graving docks, floating docks	
	4.3	Port facility: Transit shed, warehouses, cargo handling, container handling	
V	Public Transportation System		06
	5.1	Introduction: Para Transit system, Street Transit system, Rapid Transit System.	
	5.2	Route and Schedule: Properties of good route set, stopping policy and Stop location, Properties of good schedule.	
	5.3	Capacity of Transit system: Capacity of Rapid Transit system, Capacity of Street Transit system.	
VI	Bridge Engineering		06
	6.1	Introduction: History and classification of bridge, Components of bridge, Requirement of Ideal bridge, Site selection and selection of alignment of bridges, Various loads on bridges	
	6.2	Low-cost Bridges: Introduction to Causeways, Culverts, Floating bridges etc.	
	6.3	Bridge superstructure and its types, Bearings and Joints on bridges Piers, abutments, Wing walls and approaches, Types of bridge foundations	
	6.4	Bridge Hydrology: Flood Discharge, Waterway, Economic span, Scour depth, Afflux.	

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Compare different modes of transportation and describe National Urban Transport Policies.
- 2 Plan and design different elements of Airports, movements of aircrafts and helicopters.
- 3 Plan and design geometric elements of railway system and explain the elements of modern trains.
- 4 Explain different components of water transport.
- 5 Plan different public transport system, routing, scheduling and estimating transit capacity of the system.
- 6 Explain different elements of bridge and analyse various hydrological elements of bridge.

Internal Assessment**20 Marks**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination**80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Khanna S.K., Arora M.G., Jain S.S., Airport Planning & Design, Nemchand Bros., Roorkee
- 2 Saxena S.C., Railway Engineering, Dhanpat Rai & Sons, 1995
- 3 Srinivasan R., Harbours, Docks & Tunnel Engineering, Charotar Publishing House, Anand
- 4 Partha Chakroborty, Animesh Das, Principles of Transportation Engineering
- 5 Bindra S.P., Bridge Engineering, Dhanpat Rai & Sons

Reference Books:

- 1 Horenjeff Robert, The planning & Design of Airports, McGraw Hill Book Co.
- 2 Indian Railway Track: *Agarwal, M. M.*, Suchdeva Press New Delhi.
- 3 Planning Design of Airport: *Horonjeff Mckelrey*, Tata Mc-Graw Hill India Publishing House, New Delhi.
- 4 Docks & Harbour Engineering, Bindra S.P., Dhanpat Rai Publications,
- 5 Design and Construction of Ports and Marine Structures: Quinn, A. D., Tata Mc-Graw Hill India Publishing House
- 6 Transportation Engineering and Planning: C.S. Papacostas and P.D. Prevedouros; Prentice Hall India Learning Pvt. Ltd., New Delhi
- 7 Transportation Engineering: *Khisty, C.J. and Lall, Kent, B.*; Prentice Hall India Learning Pvt. Ltd., New Delhi

Semester - IV

Course Code	Course Name	Credits
CEDLO8024	Department Level Optional Course-5: Smart Building Materials	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	--	100

Rationale

A safe, comfortable, and sustainable built environment is highly desirable, as we spent most of our time in offices, factories, or homes. So smart building materials can play a vital role. Smart materials that are able to respond to an external stimulus have received great attention, especially in last two decades. These materials can change their dimensions, solubility, color, and shape, etc., upon a specific trigger. A wide range of smart materials including alloys, composites, gels, and polymers have been investigated for various applications from aerospace industry to medical technologies and now a days in the buildings and infrastructures. Smart materials can be designed with various responses and actuation mechanism based on the requirements of applications. Study of the importance and working principles of the smart materials is today's need. The concept of “smart” or “intelligent” materials, systems, and structures has been around for many years. A great deal of progress has been made recently in the development of structures that continuously and actively monitor and optimize themselves and their performance through emulating biological systems with their adaptive capabilities and integrated designs. The field of smart materials is multidisciplinary and interdisciplinary, and there are a number of enabling technologies-materials, control, information processing, sensing, actuation, and damping and system integration across a wide range of industrial applications.

Objectives

1. To study the importance of smart materials and technology
2. To Explain the types, properties of smart materials and learn to select appropriate materials.
3. To develop smart technology using smart materials
4. To Describe requirements of structural health monitoring
5. To understand the smart concrete
6. To learn applications of smart materials and technology via case studies.

Detailed Syllabus

Module	Course Modules / Contents	Periods
I	Introduction to Smart Building Materials & Technology History, importance and need, merits and demerits of smart building materials. Smart Structure system, Components, Importance of smart structures.	02
II	Fundamentals of Smart Materials Types and characteristics of smart materials:- Property-changing materials: Thermo-chromics, Photochromics, Mechanochromics, Chemochromics, Electrochromics, Liquid crystals, Suspended particle, Electrorheological, Magnetorheological Energy-exchanging materials: Electroluminescents, Photoluminescents, Chemoluminescents, Thermoluminescents, Light-emitting diodes, Photovoltaics, Energy-exchanging (reversible) materials: Piezoelectric, Pyroelectric, Thermoelectric, Electrorestrictive, Magnetorestrictive. Miscellaneous Materials: Shape Memory alloy, optical fiber, Construction chemicals, Sealants etc. Review of material, effect, working principle, advantages and disadvantages, application in Smart Structures, Use of alternative materials for structural steels and rebars.	09
III	Energy Efficient Materials, Durability and Technology Use of solar energy, wind energy, Smart window, Smart paints, Smart Wall skin, Smart roof. Green buildings and Green Material, Intelligent buildings. FRP rebars and its properties, smart lighting. Service life, Life cycle concept for structures and selection of materials for durability and sustainability. Use of Thermal and Sound Insulation systems and materials.	06
IV	Smart Structural Health Monitoring	09

	Important structural sensing parameters, Basic sensing system, Different types of sensors for monitoring stress, strain, temperature, moisture, displacements, vibration, corrosion etc. Active and passive structural health monitoring system. Specifically for buildings and bridges.	
V	Smart Concrete: Transparent concrete, Polymer modified concrete and mortars, self-healing concrete, self-compacting concrete, light weight concrete, pervious concrete, fiber reinforced concrete, temperature controlled concrete, coloured concrete- Constituents, Proportions, material properties, Importance and its application, Electrically conductive concrete, fire/ heat resistant concrete, acid resistant concrete, Ultra high performance concrete and its application in bridge engineering.	08
VI	Applications of Smart Materials and Technology: Structural health monitoring of buildings, bridges geotechnical and transportation structures, Different types of sensors their working and principles, Repairs and Rehabilitations, Modern Construction, Energy efficient Buildings- A case study.	05
		39

Contribution to Outcome

On completion of this course, the students will be able to:

1. Explain the importance of the smart materials in Civil Engineering structures.
2. Describe the working principles of the smart materials.
3. Learn to select appropriate sensors.
4. Explain the smart concrete and its use in bridges
5. Explain the use of smart materials in the structural health monitoring.
6. Describe the sensing technology and select appropriate sensors for structural health monitoring.

Recommended Books:

1. D. Michelle Addington, Daniel L. Schodek, “Smart Materials and New Technologies For the architecture and design professions”, Harvard University. ISBN0750662255.
2. Vinod K. Wadhawan, “Smart Structures: Blurring the Distinction between the Living and the Nonliving”, Oxford University place, ISBN 978-0-19-922917-8.
3. Nilesh Y. Jadhav, Green and Smart Buildings Advanced Technology Options, Springer Nature, ISBN 978-981-10-1002-6.

4. Mel Schwartz, Encyclopaedia of Smart Materials, Vol. 1 and Vol. 2, John Wiley & Sons, Inc.
5. James Sinopoli, Advanced Technology for Smart Buildings, ARTECH HOUSE, Boston, London.
6. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2015, 3rd edition, Springer, New York.
7. Jon. S. Wilson, “Sensor Technology Hand Book”, 2011, 1st edition, Elsevier, Netherland.
8. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003.
9. Structural health monitoring of civil infrastructure Systems, Edited by Vistasp M. Karbhari and Farhad Ansari, CRC Press Boca Raton Boston New York Washington, DC, Woodhead Publishing Limited, New Delhi.
10. HuaPeng Chen and Yi-Qing Ni Structural Health Monitoring of Large Civil Engineering Structures, John Wiley & Sons Ltd, 2018.
11. SP-7 (National Building Code of India), Bureau of Indian Standards.

Semester-VII		
Subject Code	Subject Name	Credits
CEDLO8025	Department Level Optional Course 6: Structural Dynamics	3

Contact Hours			Credits Assigned			
Theory	Practical	Tutorials	Theory	Practical	TW/Tutorials	Total
3	--	--	3	--	--	3

Evaluation Scheme								
Theory					Termwork/Practical/ Oral/Tutorials			Total
Internal Assessments			ESE	Durationof ESE	TW/TU	PR	OR	
IA-I	IA-II	Avg.						
20	20	20	80	3 Hr	--	--	--	

Course Objective

- To expose the students to the basic theory of structural dynamics, structural behaviour under vibratory load and the effect of damping.
- To study the difference between static load and different types of dynamic loads.
- To study the free vibration analysis of SDOF systems, concept of damping and dynamic analysis of SDOF system subjected to different dynamic loads.
- To study the dynamic degrees of freedom and calculation of the frequencies and mode shapes for lumped mass for discrete Two DOF systems,
- To study the modal analysis of Two DOF systems and analysis of systems with distributed mass for continuous system.

Detailed Syllabus

Module	Contents	Hrs
I	Introduction to structural Dynamics- Definition of Basic Problem in Dynamics. Static vs. Dynamic loads. Different types of dynamics loads	4
II	Introduction to single Degree of freedom (SDOF) Systems. Undamped vibration of SDOF system natural frequency and period of vibration. Damping in structures, viscous damping and Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, Logarithmic decrement. Forced vibration, response to periodic loading, response to pulsating forces, dynamic load factor. Response of structure subjected to General dynamic load, Duhamel's Integral Numerical. Evaluation of Dynamics Response of SDOF system. Equivalent stiffness of spring in series and parallel.	8

III	Introduction to Distributed mass system. Distributed mass system idealized as SDOF system, use of Rayleigh's method. Response of SDOF system subjected to ground motion	4
IV	Lumped mass multi-degree of freedom (Two DOF) system, coupled and uncoupled system Direct determination of frequencies of vibration and mode shape. Orthogonality principle. Vibration of Two DOF systems with initial conditions Approximate method of determination of natural frequencies of vibration and mode shapes – Energy methods	9
V	Earthquake analysis – Introduction. Seismicity of a region, causes of earthquake Intensity of earthquake, Richter Scale, Measurement of Earthquake ground motion, Seismogram, construction of seismograph Application of modal analysis concept to seismic disturbance, Introduction to Response spectrum method.	8
VI	I.S code provisions for seismic analysis of buildings. Approximate method of earthquake analysis– Seismic co-efficient method and its limitation. Introduction to time history analysis.	6

Contributions to Outcomes

On completion of the course, the students will be able to

- Summarize the difference between static and dynamic loads and analysis.
- Evaluate the response of SDOF systems for different types of dynamic loads including ground motions.
- Describe Distributed mass system idealized as SDOF system
- Evaluate the response of MDOF systems to different types of dynamic loads including ground motions.
- Explain the basics of Concepts of Earthquake analysis.
- Describe the I.S code provisions for seismic analysis of buildings.

Theory Examination:

- Question paper will comprise of six questions; each carrying 20 marks.
- The first question will be compulsory which will have the short questions covering the entire syllabus.
- The remaining five questions will be based on all the modules of entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub-module and contents thereof.
- There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- The students will have to attempt any three questions out of remaining five questions.
- Total four questions need to be attempted.

Recommended Books:-

1. Craig R.R.: 'Structural Dynamics-An Introduction to Computer Methods', *John Wiley and Sons*.
2. Anil K. Chopra: 'Dynamics of Structures', *Prentice Hall India Pvt. Ltd.*
3. Cloguhand Penzein: 'Dynamics of Structures' *TataMc-Graw Hill Pvt. Ltd.*
4. John M. Biggs: 'Structural Dynamics', *Tata Mc-Graw Hill*.
5. Mario Paz: 'Structural Dynamics Theory and Computation', *CBS Publisher*.

Semester VIII

Course Code	Course Name	Credits
CEDLO8026	Department Level Optional Course 6: Ground water Engineering	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 hours	-	-	-	100

Rationale

This subject deals with the various processes involved in ground water Engineering which provides in depth understanding of the theories and concepts of hydrological parameters, well hydraulics, ground water quality etc. It also explains the concept of basin water management concept and its evaluation.

Objectives

- 1 To introduce the student to the principles of hydrological parameters
- 2 To Explain to the students the principles of Well Hydraulics.
- 3 To introduce the student the concept of ground water quality and conservation.
- 4 To introduce the student the concept of basin management

Detailed Syllabus

Module	Course Module / Contents		Hr
I	Hydrogeological Parameters		6
	1.1	Introduction – Water bearing Properties of Rock – Type of aquifers - Aquifer properties	
	1.2	permeability, specific yield, transmissivity and storage coefficient – Methods of Estimation	
	1.3	GEC norms - Steady state flow - Darcy's Law - Groundwater Velocity – Dupuit Forchheimer assumption	
	1.4	Steady Radial Flow into a Well	

II	Well Hydraulics		8
	2.1	Unsteady state flow - Theis method - Jacob method	
	2.2	Chow's method – Law of Times – Theis Recovery	
	2.3	Bailer method – Slug method - tests - Image well theory	
	2.4	Partial penetrations of wells – Well losses	
	2.5	Specific Capacity and Safe yield	
	2.6	Collector well and Infiltration gallery	
III	Groundwater Management		6
	3.1	Need for Management Model – Database for Groundwater Management – Groundwater	
	3.2	Balance study – Introduction to Mathematical model – Model Conceptualization	
	3.3	Initial and Boundary Condition – Calibration – Validation – Future Prediction – Sensitivity	
	3.4	Analysis – Uncertainty – Development of a model	
IV	Groundwater Quality		7
	4.1	Ground water chemistry - Origin, movement and quality - Water quality standards	
	4.2	Drinking water – Industrial water – Irrigation water	
	4.3	Ground water Pollution and legislation	
	4.4	Environmental Regulatory requirements	
V	Groundwater Conservation		5
	5.1	Artificial recharge techniques – Reclaimed wastewater recharge – Soil aquifer treatment (SAT)	
	5.2	Aquifer Storage and Recovery (ASR) Seawater Intrusion and Remediation	
	5.3	Ground water Basin management and Conjunctive use	
	5.4	Protection zone delineation, Contamination source inventory and remediation schemes Name of Module 6 Management of Groundwater	
VI	6.1	Concept of basin management	7
	6.2	Ground water basin investigations	
	6.3	Basin management and conjunctive use	
	6.4	Basin yields	

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Apply the principals of hydrological parameters for design of wells.
- 2 Calculate the specific yield and yield of well under different ground water conditions.
- 3 Develop a model for groundwater management.
- 4 Explain the concept of ground water quality models

Internal Assessment

20 Marks

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Numerical Ground Water Hydrology: A.K. Rastogi, Penram International Publishing, Mumbai, 2007
- 2 Ground Water Hydrology: D.K. Todd, John Wiley & Sons, New York, USA, 1980
- 3 Ground water Hydrology by A. K. Rastogi
- 4 Hydrology- Principles, Analysis, Design: H.M. Raghunath, New Age International Publishers.
- 5 Engineering Hydrology: C.S.P. Ojha, R. Berndtsson, & P. Bhunya, Oxford University Press

Reference Books:

- 1 Fitts R Charles, "Groundwater Science". Elsevier, Academic Press, 2002.
- 2 Ramakrishnan, S, Ground Water, K.J. Graph arts, Chennai, 1998

Semester VIII		
Subject Code	Subject Name	Credits
ILOC8011	Institute Level Optional Course – II : Project Management	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:	
- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques. - To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.	

Module	Detailed Contents	Hrs
I	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
II	Initiating Projects: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
III	Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
IV	Planning Projects: Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.	6

	Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	
V	5.1 Executing Projects: Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. 5.2 Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. 5.3 Project Contracting Project procurement management, contracting and outsourcing,	8
VI	6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects. Multicultural and virtual projects. 6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Outcomes	
Students will be able to : • Apply selection criteria and select an appropriate project from different options. • Write work break down structure for a project and develop a schedule based on it. • Identify opportunities and threats to the project and decide an approach to deal with them strategically. • Use Earned value technique and determine & predict status of the project. • Capture lessons learned during project phases and document them for future reference	

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 questions

- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9th Ed.

Semester VIII		
Course Code	Course Name	Credits
ILOC8012	Institute Level Optional Course – II : Finance Management	03

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Module	Detailed Contents	Hrs
I	Overview of Indian Financial System: Characteristics, Components and Functions of Financial System. Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
II	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
III	Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios;	09

	Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
IV	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
V	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
VI	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Outcomes	
Students will be able to...	- Describe Indian finance system and corporate finance - Take investment, finance as well as dividend decisions

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.

Semester VIII		
Course Code	Course Name	Credits
ILOC8013	Institute Level Optional Course – II : Entrepreneurship Development and Management	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:
- To acquaint with entrepreneurship and management of business - Understand Indian environment for entrepreneurship - Idea of EDP, MSME

Module	Detailed Contents	Hrs
I	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
II	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
III	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises.	05
IV	Indian Environment for Entrepreneurship: key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships,	08

	National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
V	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
VI	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Outcomes:

Students will be able to...

- Explain the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Describe government policies for entrepreneurs

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of total six question carrying 20 marks
2. Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.
4. Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Semester VIII		
Course Code	Course Name	Credits
ILOC8014	Institute Level Optional Course – II : Human Resource Management	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:	
- To introduce the students with basic concepts, techniques and practices of the human resource management. - To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations. - To familiarize the students about the latest developments, trends & different aspects of HRM. - To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.	

Module	Detailed Contents	Hrs
I	Introduction to HR Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
II	Organizational Behavior (OB) Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	7
III	Organizational Structure & Design Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.	6

	Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
IV	Human resource Planning Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training Methods	5
V	Emerging Trends in HR Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
VI	HR & MIS Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries) Strategic HRM Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals Labour Laws & Industrial Relations Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Contribution to Outcomes:

Students will be able to:

- Explain the concepts, aspects, techniques and practices of the human resource management.
- Describe the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of total six question carrying 20 marks

2. Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.
4. Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Semester VIII		
Course Code	Course Name	Credits
ILOC8015	Institute Level Optional Course – II : Professional Ethics and CSR	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20						

Objectives:
- To understand professional ethics in business - To recognized corporate social responsibility

Module	Detailed Contents	Hrs
I	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
II	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
III	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
IV	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
V	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP)	08
VI	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Contribution to outcomes

Students will be able to...

- Summarize rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Explain legal aspects of corporate social responsibility

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. **Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.**

Semester VIII		
Course Code	Course Name	Credits
ILOC8016	Institute Level Optional Course – II : Research Methodology	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:
- To understand Research and Research Process - To acquaint students with identifying problems for research and develop research strategies - To familiarize students with the techniques of data collection, analysis of data and interpretation

Module	Detailed Contents	Hrs
I	Introduction and Basic Research Concepts 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
II	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
III	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
IV	Research Methodology 4.1 Meaning of Research Methodology	08

	4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	
V	Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
VI	Outcome of Research 6.1 Preparation of the report on conclusion reached 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation	04

Course Outcomes

Students will be able to:

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

SemesterVIII		
Course Code	Course Name	Credits
ILOC8017	Institute Level Optional Course – II : IPR & Patenting	03

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Module	Detailed Contents	Hr
I	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
II	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
III	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
IV	Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07

V	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
VI	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	07

Outcomes:

Students will be able to...

- Explain Intellectual Property assets
- assist individuals and organizations in capacity building
- work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

Reference Books:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial

Publications

10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Semester VIII		
Course Code	Course Name	Credits
ILOC8018	Institute Level Optional Course – II : Digital Business Management	03

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme								
Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:
- To familiarize with digital business concept - To acquaint with E-commerce - To give insights into E-business and its strategies

Module	Detailed content	Hrs
I	Introduction to Digital Business- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
II	Overview of E-Commerce E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
III	Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure	06
IV	Managing E-Business- Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce	06

	Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	
V	E-Business Strategy -E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
VI	Caterializing e-business: From Idea to Realization-Case Studies and presentations	08

Outcomes:

Students will be able to:

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Assessment:

Internal:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. A textbook on E-commerce, Er. Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:[10.1787/9789264221796-en](https://doi.org/10.1787/9789264221796-en)OECD Publishing

Semester VIII		
Course Code	Course Name	Credits
ILOC8019	Institute Level Optional Course – II : Environmental Management	03

Teaching Scheme

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	--	03	--	--	03

Evaluation Scheme

Theory					Term work / Practical / Oral			Total Marks
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test 1	Test 2	Avg						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Module	Detailed Contents	Hrs
I	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
II	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
III	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
IV	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
V	Total Quality Environmental Management, ISO-14000, EMS certification.	05
VI	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Contribution to Outcomes

Students will be able to...

- Describe the concept of environmental management
- Evaluate ecosystem and interdependence, food chain etc.
- Compare and interpret environment related legislations

Assessment:**Internal:**

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.

- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing. 2015

Semester-VIII

Course Code	Course Name	Credits
CEL801	Construction Management	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	-	02	-		01	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	--	25	50

Course Objective:

- 1 To understand the basic functions and construction management.
- 2 To apply scheduling techniques such as CPM & PERT
- 3 To gain knowledge of time-cost optimization & effective utilization of resources on construction sites.
- 4 To gain knowledge of time-cost optimization & effective utilization of resources on construction sites.
- 5 To know about safety and quality aspect of construction works.

Course Outcomes:

At the end of the course, learner will be able to:

- 1 Summarize & apply the knowledge of management functions like planning, scheduling, Executing & controlling the construction projects.
- 2 Prepare feasible project schedule by using various scheduling techniques.
- 3 Gain knowledge of managing various resources & recommend best method of allocating resources to the project.
- 4 Develop optimum relationship between time & cost for construction project.
- 5 Implement quality & safety measures on construction sites during execution of Civil Engineering projects.
- 6 Explain the importance of labour acts.

List of Assignments

Module No.	Assignment	Tutorial Hr.
1	Assignment No. 1: Principles, Functions, and contribution eminent personalities towards Management	02
2	Assignment No.2: Project classifications, Unique features of construction, Various agencies involved in construction industry	02
3	Assignment No.3: Bar Charts its limitations and its uses Numerical on development of networks and calculation of floats using CPM technique.	02
4	Assignment No.4: Assumption underlying PERT analysis time estimates, slack& its types, probability of completing the project.	02
5	Assignment No.5: Numerical on Resources Allocation Methods- Resource levelling and Smoothing	02
6	Assignment No.6: Procedure and Numerical on Time and cost optimization in construction projects - Compression & decompression of network.	02
7	Assignment No.7: Network Updating- Purpose and frequency of updating. Numerical on Project Updating	02
8	Assignment No.8: Construction Safety, Quality Control & Labour Acts	02

Term Work

Comprises of Assignments, which has to be submitted by each student individually.

Distribution of marks for Term Work shall be as follows:

Assignments: 20 Marks
Attendance : 05 Marks

Further, while giving **weightage of marks on the attendance, following guidelines shall be resorted to.**

Attendance	Marks awarded
75%- 80%	03 Marks
81%- 90%	04 Marks
91% onwards	05 Marks

End Semester Oral Examination: The oral examination shall be based on the entire syllabus & the Term-work prepared by the students including assignments.

Reference Books:

- 1 Construction Engineering and Management: S. Seetharaman.
- 2 Construction Planning & Management – Dr. U. K. Shrivastava.
- 3 Construction Project Management: Chitkara K. K. Tata McGraw Hill.
- 4 Construction Projects planning and Management: P. S. Gahlot and Dhir New Age International (p) Publishers
- 5 Critical Path Methods in Construction Practice: Antill J M &Woodhead R W, Wiley
- 6 Construction Hazard and Safety Handbook: King &Hudson, Butterworth

Semester - VIII								
Course Code			Course Name					Credits
CEP801			Major Project- Part II					06
Contact Hours			Credits Assigned					
Theory	Practical	Tutorial	Theory		Practical	Tutorial		Total
-	12\$	-	-		6	-		6
Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test–I	Test–II	Average						
-	-	-	-	-	50	-	100	

Rationale

In the field of Civil Engineering, new problems arise every now and then; but a professional civil engineer must know how to precisely identify & state those problems, define the scope & objectives of the probable solution(s), carry out effective review of available literature in the domain of the problem and formulate a systematic methodology to solve the problem. Modern tools and multidisciplinary knowledge are vastly used nowadays for the effective solution of civil engineering problem. It is also important to work effectively & ethically as a team and communicate the work done in the form of written reports. The aim of this course is to acquaint the learners with all of the above-mentioned aspects of the civil engineering field by inculcating the process of research

Objectives

1. To acquaint the learners to analyse the problem.
2. To accustom the learners to apply various techniques and methods.
3. To familiarize the learners about interpreting the results and discuss the issues.
4. To advice the learners to write and infer conclusions of the project.
5. To accustom the learners to work as a team.
6. To apprise the learners on proper documentation of work.

Detailed Syllabus

After completion of the work at the end of Semester VIII, the student shall compile the report in a standard format and written in the systematic manner and chapter wise.

The student shall adhere to the following scheme of chapterization while compiling the final report in general. The Guide/ Supervisor shall ensure the student has written the Dissertation Report in appropriate language (grammatically correct).

Contribution to Outcomes

On completion of this course, the students will be able to:

- 1: Perform on analytical, experimental or numerical method to solve identified problem
- 2: Produce alternative design solution to meet the functional requirements of the defined problem.
- 3: Represent the data in Tabular or graphical forms so as to facilitate, analysis & explain of the data.
- 4: Express Engineering principles & manage the finance required for the execution of the Project.
- 5: Infer at results, conclusion with its validation, also propose the future scope of work on the identified problem.
- 6: Communicate effectively their project work by writing reports and publishing technical papers based on entire project work.

Guidelines for Assessment of Project II

Project II should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. Quality of Written and Oral Presentation

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines. Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai

Students should be motivated to publish a paper in Conferences/students competitions based on the work

AC – 11 July, 2022

Item No. – 6.41 (R)

University of Mumbai



Bachelor of Engineering

in

Computer Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

University of Mumbai



Sr. No.	Heading	Particulars
1	Title of the Course	Fourth Year Engineering (Computer Engineering)
2	Eligibility for Admission	After Passing Second Year Engineering as per the Ordinance 0.6243
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	Ordinance 0.6243
5	No. of Years / Semesters	8 semesters
6	Level	P.G. / U.G./ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / Semester (Strike out which is not applicable)
8	Status	~~New~~/ Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	With effect from Academic Year:2021-2022

Dr. S.K.Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2021-22. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2022-23, 2023-24, respectively.

Dr. S.K. Ukarande

Associate Dean

Faculty of Science and Technology

University of Mumbai

Dr Anuradha Muzumdar

Dean

Faculty of Science and Technology

University of Mumbai

Incorporation and Implementation of Online Contents **from NPTEL/ Swayam Platform**

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S.K.Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface by Board of Studies in Computer Engineering

Dear Students and Teachers, we, the members of Board of Studies Computer Engineering, are very happy to present Third Year Computer Engineering syllabus effective from the Academic Year 2021-22 (REV-2019'C' Scheme). We are sure you will find this syllabus interesting, challenging, fulfill certain needs and expectations.

Computer Engineering is one of the most sought-after courses amongst engineering students. The syllabus needs revision in terms of preparing the student for the professional scenario relevant and suitable to cater the needs of industry in present day context. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. It is intended to provide a modern, industry-oriented education in Computer Engineering. It aims at producing trained professionals who can successfully acquainted with the demands of the industry worldwide. They obtain skills and experience in up-to-date the knowledge to analysis, design, implementation, validation, and documentation of computer software and systems.

The revised syllabus is finalized through a brain storming session attended by Heads of Departments or senior faculty from the Department of Computer Engineering of the affiliated Institutes of the Mumbai University. The syllabus falls in line with the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of the revised syllabus are:

1. Reduction in credits to 170 is implemented to ensure that students have more time for extracurricular activities, innovations, and research.
2. The department Optional Courses will provide the relevant specialization within the branch to a student.
3. Introduction of Skill Based Lab and Mini Project to showcase their talent by doing innovative projects that strengthen their profile and increases the chance of employability.
4. Students are encouraged to take up part of course through MOOCs platform SWAYAM

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Board of Studies in Computer Engineering

Prof. Sunil Bhirud	: Chairman
Prof. SunitaPatil	: Member
Prof. Leena Ragha	: Member
Prof. Subhash Shinde	: Member
Prof .Meera Narvekar	: Member
Prof. Suprtim Biswas	: Member
Prof. Sudhir Sawarkar	: Member
Prof. Dayanand Ingle	: Member
Prof. Satish Ket	: Member

Program Structure for Fourth Year Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2022-2023)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract. Tut.		Theory	Pract.	Total		
CSC701	Machine Learning	3	--		3	--	3		
CSC702	Big Data Analytics	3	--		3		3		
CSDC 701X	Department Level Optional Course-3	3	--		3	--	3		
CSDC 702X	Department Level Optional Course-4	3	--		3	--	3		
ILO 701X	Institute Level Optional Course-1	3	--		3	--	3		
CSL701	Machine Learning Lab	--	2		--	1	1		
CSL702	Big Data Analytics Lab	--	2		--	1	1		
CSDL 701X	Department Level Optional Course-3 Lab	--	2		--	1	1		
CSDL 702X	Department Level Optional Course-4 Lab	--	2		--	1	1		
CSP701	Major Project 1	--	6 [#]		--	3	3		
Total		15	14		15	7	22		
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
CSC701	Machine Learning	20	20	20	80	3	--	--	100
CSC702	Big Data Analysis	20	20	20	80	3	--	--	100
CSDC 701X	Department Level Optional Course-3	20	20	20	80	3	--	--	100
CSDC 702X	Department Level Optional Course-4	20	20	20	80	3	--	--	100
ILO 701X	Institute Level Optional Course-1	20	20	20	80	3	--	--	100
CSL701	Machine Learning Lab	--	--	--	--	--	25	25	50
CSL702	Big Data Analytics Lab	--	--	--	--	--	25	25	50
CSDL 701X	Department Level Optional Course-3 Lab						25	-	25
CSDL 702X	Department Level Optional Course-4 Lab	--	--	--	--	--	25	-	25
CSP701	Major Project 1	--	--	--	--	--	50	25	75
Total		--	--	100	400	--	150	75	725

Program Structure for Fourth Year Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)				Credits Assigned			
		Theory			Pract. Tut.	Theory	Pract.	Total	
CSC801	Distributed Computing	3			--	3	--	3	
CSDC 801X	Department Level Optional Course -5	3			--	3	--	3	
CSDC 802X	Department Level Optional Course -6	3			--	3	--	3	
ILO 801X	Institute Level Optional Course -2	3			--	3	--	3	
CSL801	Distributed Computing Lab	--			2	--	1	1	
CSDL 801X	Department Level Optional Course -5 Lab	--			2	--	1	1	
CSDL 802X	Department Level Optional Course -6 Lab	--			2	--	1	1	
CSP801	Major Project 2	--			12 [#]	--	6	6	
Total		12			18	12	9	21	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
CSC801	Distributed Computing	20	20	20	80	3	--	--	100
CSDC 801X	Department Level Optional Course -5	20	20	20	80	3	--	--	100
CSDC 802X	Department Level Optional Course -6	20	20	20	80	3	--	--	100
ILO 801X	Institute Level Optional Course -2	20	20	20	80	3	--	--	100
CSL801	Distributed Computing Lab	--	--	--	--	--	25	25	50
CSDL 801X	Department Level Optional Course -5 Lab	--	--	--	--	--	25	25	50
CSDL 802X	Department Level Optional Course -6 Lab						25	25	50
CSP801	Major Project- 2	--	--	--	--	--	100	50	150
Total		--	--	80	320	--	175	125	700

Major Project 1 and 2 :

- Students can form groups with minimum 2 (Two) and not more than 4 (Four)
- Faculty Load : In Semester VII – ½ hour per week per project group
In Semester VIII – 1 hour per week per project group

Program Structure for Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2022-2023)

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject
VII	Department Optional Course -3	CSDC7011: Machine Vision CSDC7012: Quantum Computing CSDC7013: Natural Language Processing
	Department Optional Lab -3	CSDL7011: Machine Vision Lab CSDL7012: Quantum Computing Lab CSDL7013: Natural Language Processing Lab
	Department Optional Course -4	CSDC7021 : Augmented and Virtual Reality CSDC7022 : Block Chain CSDC7023 : Information Retrieval
	Department Optional Lab -4	CSDL7021 : Augmented and Virtual Reality Lab CSDL7022 : Block Chain Lab CSDL7023 : Information Retrieval Lab
	Institute level Optional Courses-I	ILO7011. Product Lifecycle Management ILO7012. Reliability Engineering ILO7013. Management Information System ILO7014. Design of Experiments ILO7015. Operation Research ILO7016. Cyber Security and Laws ILO7017. Disaster Management & Mitigation Measures ILO7018. Energy Audit and Management ILO7019. Development Engineering

Program Structure for Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2022-2023)

Department and Institute Optional Courses and Labs

Semester	Department/ Institute Optional Courses and Labs	Subject
VIII	Department Optional Course -5	CSDC8011 : Deep Learning CSDC8012 : Digital Forensic CSDC8013 : Applied Data Science
	Department Optional Lab -5	CSDL8011 : Deep Learning Lab CSDL8012 : Digital Forensic Lab CSDL8013 : Applied Data Science Lab
	Department Optional Course -6	CSDC8021 : Optimization in Machine Learning CSDC8022: High Performance Computing CSDC8023: Social Media Analytics
	Department Optional Lab -6	CSDL8021 : Optimization in Machine Learning Lab CSDL8022: High Performance Computing Lab CSDL8023: Social Media Analytics Lab
	Institute level Optional Courses-II	ILO8021. Project Management ILO8022. Finance Management ILO8023. Entrepreneurship Development and Management ILO8024. Human Resource Management ILO8025. Professional Ethics and CSR ILO8026. Research Methodology ILO8027. IPR and Patenting ILO8028. Digital Business Management ILO8029. Environmental Management

Course Code:	Course Title	Credit
CSC701	Machine Learning	3

Prerequisite: Engineering Mathematics, Data Structures, Algorithms

Course Objectives:

1	To introduce the basic concepts and techniques of Machine Learning.
2	To acquire in depth understanding of various supervised and unsupervised algorithms
3	To be able to apply various ensemble techniques for combining ML models.
4	To demonstrate dimensionality reduction techniques.

Course Outcomes:

1	To acquire fundamental knowledge of developing machine learning models.
2	To select, apply and evaluate an appropriate machine learning model for the given
3	To demonstrate ensemble techniques to combine predictions from different models.
4	To demonstrate the dimensionality reduction techniques.

Module		Content	Hrs
1		Introduction to Machine Learning	04
	1.1	Machine Learning, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application.	
	1.2	Training Error, Generalization error, Overfitting, Underfitting, Bias-Variance trade-off.	
2		Learning with Regression and Trees	09
	2.1	Learning with Regression: Linear Regression, Multivariate Linear Regression, Logistic Regression.	
	2.2	Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index (Regression), Classification and Regression Trees (CART)	
	2.3	Performance Metrics: Confusion Matrix, [Kappa Statistics], Sensitivity, Specificity, Precision, Recall, F-measure, ROC curve	
3		Ensemble Learning	06
	3.1	Understanding Ensembles, K-fold cross validation, Boosting, Stumping, XGBoost	
	3.2	Bagging, Subbagging, Random Forest, Comparison with Boosting, Different ways to combine classifiers	
4		Learning with Classification	08
	4.1	Support Vector Machine Constrained Optimization, Optimal decision boundary, Margins and support vectors, SVM as constrained optimization problem, Quadratic Programming, SVM for linear and nonlinear classification, Basics of	

		Kernel trick.	
	4.2	Support Vector Regression, Multiclass Classification	
5		Learning with Clustering	07
	5.1	Introduction to clustering with overview of distance metrics and major clustering approaches.	
	5.2	Graph Based Clustering: Clustering with minimal spanning tree Model based Clustering: Expectation Maximization Algorithm, Density Based Clustering: DBSCAN	
6		Dimensionality Reduction	05
	6.1	Dimensionality Reduction Techniques, Principal Component Analysis, Linear Discriminant Analysis, Singular Valued Decomposition.	
Total			39

Textbooks:	
1	Peter Harrington, “Machine Learning n Action”, DreamTech Press
2	Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press
3	Tom M. Mitchell, “Machine Learning” McGraw Hill
4	Stephen Marsland, “Machine Learning An Algorithmic Perspective”, CRC Press
References:	
1	Han Kamber, —Data Mining Concepts and Techniques, Morgan Kaufmann Publishers
2	Margaret. H. Dunham, —Data Mining Introductory and Advanced Topics, Pearson Education
3	Kevin P. Murphy , Machine Learning — A Probabilistic Perspective
4	Samir Roy and Chakraborty, —Introduction to soft computing, Pearson Edition.
5	Richard Duda, Peter Hart, David G. Stork, “Pattern Classification”, Second Edition, Wiley Publications.
<u>Assessment:</u>	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and the second class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.

5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Digital Links	
1	Data sets for Machine Learning algorithms: https://www.kaggle.com/datasets
2	Machine Learning repository- https://archive.ics.uci.edu/ml/index.php
3	Machine Learning from Coursera
4	https://towardsdatascience.com/machine-learning/home
5	https://onlinecourses.nptel.ac.in/noc21_cs85/preview

Course Code	Course Name	Credit
CSC702	Big Data Analysis	03

Prerequisite: Database, Data mining.

Course Objectives: The course aims:

1	To provide an overview of the big data platforms, its use cases and Hadoop ecosystem.
2	To introduce programming skills to build simple solutions using big data technologies such as MapReduce, Scripting for No SQL and R
3	To learn the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4	To enable students to have skills that will help them to solve complex real-world problems for decision support.

Course Outcomes:

1	Understand the building blocks of Big Data Analytics.
2	Apply fundamental enabling techniques like Hadoop and MapReduce in solving real world problems.
3	Understand different NoSQL systems and how it handles big data.
4	Apply advanced techniques for emerging applications like stream analytics.
5	Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications, etc.
6	Apply statistical computing techniques and graphics for analyzing big data.

Module		Detailed Content	Hours
1		Introduction to Big Data and Hadoop	2
	1.1	Introduction to Big Data - Big Data characteristics and Types of Big Data	
	1.2	Traditional vs. Big Data business approach	
	1.3	Case Study of Big Data Solutions	
	1.4	Concept of Hadoop, Core Hadoop Components; Hadoop Ecosystem	
2		Hadoop HDFS and MapReduce	8
	2.1	Distributed File Systems: Physical Organization of Compute Nodes, Large-Scale File-System Organization.	
	2.2	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.	
	2.3	Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union ,Intersection, and Difference by MapReduce	

	2.4	Hadoop Limitations	
3		NoSQL	10
	3.1	Introduction to NoSQL, NoSQL Business Drivers	
	3.2	NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study	
	3.3	NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems.	
4		Mining Data Streams	11
	4.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing.	
	4.2	Sampling Data techniques in a Stream	
	4.3	Filtering Streams: Bloom Filter with Analysis.	
	4.4	Counting Distinct Elements in a Stream, Count-Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements	
	4.5	Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.	
5		Real-Time Big Data Models	4
	5.1	A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering	
	5.2	Case Study: Product Recommendation	
	5.3	Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph	
6		Data Analytics with R	4
	6.1	Exploring Basic features of R, Exploring RGUI, Exploring RStudio, Handling Basic Expressions in R, Variables in R, Working with Vectors, Storing and Calculating Values in R, Creating and using Objects, Interacting with users, Handling data in R workspace, Executing Scripts, Creating Plots, Accessing help and documentation in R	
	6.2	Reading datasets and Exporting data from R, Manipulating and Processing Data in R, Using functions instead of script, built-in functions in R	
	6.3	Data Visualization: Types, Applications	

Textbooks:	
1	Cre Anand Rajaraman and Jeff Ullman —Mining of Massive Datasets , Cambridge University Press
2	Alex Holmes —Hadoop in Practice , Manning Press, Dreamtech Press.
3	Dan Mcary and Ann Kelly —Making Sense of NoSQL – A guide for managers and the rest of us, Manning Press.
4	DT Editorial Services, “Big Data Black Book”, Dreamtech Press
5	EMC Education Services, ”Data Science and Big Data Analytics”, Wiley

References:

1	Bill Franks , —Taming The Big Data Tidal Wave: Finding Opportunities In HugeData StreamsWithAdvancedAnalytics ,Wiley
2	Chuck Lam, —Hadoop inAction , Dreamtech Press
3	Jared Dean, —Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners ,Wiley India Private Limited, 2014.
4	Jiawei Han and Micheline Kamber, —Data Mining: Concepts and Techniques , Morgan Kaufmann Publishers, 3rd ed, 2010.
5	Lior Rokach and Oded Maimon, —Data Mining and Knowledge Discovery Handbook , Springer, 2nd edition,2010.
6	Ronen Feldman and James Sanger, —The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data , Cambridge University Press, 2006.
7	Vojislav Kecman, —Learning and Soft Computing , MITPress, 2010.

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links

1	https://nptel.ac.in/courses/106104189
2	https://www.coursera.org/specializations/big-data#courses
3	https://www.digimat.in/nptel/courses/video/106106169/L01.html
4	https://www.coursera.org/learn/nosql-databases#syllabus
5	https://www.coursera.org/learn/basic-recommender-systems#syllabus

Course Code	Course Name	Credit
CSDC7011	Machine Vision	03

Pre-requisite: Computer Graphics	
Course Objectives: The course aims:	
1	To understand the need and significance Machine Vision
2	To explore basics of image processing
3	To explore the components of Machine Vision System
4	To develop application using machine Vision
5	To study transformation, interpolation, filters.
Course Outcomes: Learners will be able to	
1	Elaborate the components of Machine Vision Application
2	Perform image ,video preprocessing operations
3	Explain various transformations, interpolation.
4	Elaborate motion tracking in video.
5	Analyze and Implement appropriate filtering techniques for a given problem.
6	Develop applications based on machine vision..

Module		Detailed Content	Hours
1		Introduction to Machine Vision	4
		Computer and Human Vision Systems., The Human Eye, Computer versus Human Vision Systems, Evolution of Computer Vision, Computer/Machine Vision and Image Processing, Applications of Computer Vision	
2		Digital Image Fundamentals	8
		Digital Image, Monochrome and Color Images, Image Brightness and Contrast., 2D, 3D, and 4D Images, Digital Image Representation , Digital Image File Formats, Fundamental Image Operations, Points, Edges, and Vertices , Point Operations , Thresholding ,Brightness, Geometric Transformations , Spatial Transformation , Affine Transformation, Image Interpolation ,Nearest-Neighbor Interpolation ,Bilinear Interpolation , Bi-cubic Interpolation ,Fundamental Steps in Digital Image Processing.	
3		Machine Vision and System Components	8
		Machine Vision System, Machine Vision Camera: CCD and CMOS Image Sensors, TDI Sensor, Camera Type - Area Scan Cameras, Line Scan Cameras, Smart Cameras, Camera Lens-Resolution, Contrast and Sharpness, Lenses and their parameters: Types of Lenses, Lens Mounts, Lens Selection Examples-Field of	

		View Much larger than Camera sensor size or Smaller or close to Camera Sensor size, Machine Vision Lighting: Lighting: Light Sources in Machine Vision, Illumination Techniques-Backlighting, Front Lighting, Diffused Lighting, Oblique Lighting, Dark Field Lighting, Infrared and Ultraviolet Light, Filters, Machine Vision Software, Machine Vision Automation, Integration of Machine Vision Components	
4		Digital Image Processing for Machine Vision Applications	10
		Preprocessing., Image Filtering, Normalized Box Filter Gaussian Filter Bilateral Filter, Comparison of Filter Techniques, Sub sampling/Scaling Histogram, Image Segmentation, Threshold-Based Segmentation Edge-Based Segmentation First-Order Derivative Edge Detection. Second-Order Derivative Operators, Comparison of Edge Detection Techniques, Region-Based Segmentation Region Growing Methods, Region Split and Merge Method, Morphological Image Processing: Dilation, Erosion, Opening, Closing, Hit-or-Miss transformation, Object Recognition. Template Matching. Blob Analysis	
5		Motion Analysis	4
		Differential motion Analysis, Optical Flow, Analysis based on correspondence of interest points, Detection of specific motion Patterns, Video Tracking	
6		Emerging Trends in Machine Vision	5
	6.1	History of Industrial Revolution(s), Machine Vision and Industry 4.0, Emerging Vision Trends in Manufacturing, 3D Imaging, Emerging Vision Trends in Manufacturing,	
	6.2	Applications in Machine/ Computer Vision: Face detection, face recognition, eigen faces, car on roads	

Textbooks:	
1.	Sheila Anand and L.Priya , “A Guide for Machine Vision in Quality Control”, Taylor & Francis Inc, Imprint CRC Press Inc, Dec 2019
2.	Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Pearson
3.	Carsten Stegar, Markus Ulrich, and Christian Wiedemann , “Machine Vision Algorithms and Applications”,Second completely Revised and Enlarged Edition
4.	Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing Analysis and Machine Vision”, Second Edition, Cengage Learning.
References:	

1.	Chiranjilal Chowdhary, Mamoun Alazab, Ankit Chaudhary, SaqibHakak and Thippa Reddy Gadekallu ,”Computer Vision and Recognition Systems Using Machine and Deep Learning Approaches, Fundamentals, technologies and applications” , IET COMPUTING SERIES 42
2	Joe Minichino Joseph Howse ,”Learning OpenCV 3 Computer Vision with Python”, Second Edition, Packt Publishing Ltd.
3.	Alexander Hornberg,, “ Handbook of Machine and Computer Vision The Guide for Developers and Users,

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links

1	https://nptel.ac.in/courses/108103174
2	https://www.coursera.org/learn/introduction-computer-vision-watson-opencv
3	https://www.udacity.com/course/introduction-to-computer-vision--ud810
4	https://onlinecourses.nptel.ac.in/noc21_ee23/preview

Course Code	Course Title	Credit
CSDC7012	Quantum Computing	3

Prerequisite: Engineering Mathematics, Data Structures and Algorithm, Python Programming

Course Objectives:

1	To understand basics of quantum computing
2	To understand mathematics required for quantum computing
3	To understand building blocks of quantum computing and design algorithms
4	To understand quantum hardware principles and tools for quantum computing.

Course Outcomes: After successful completion of the course student will be able to

1	Understand basic concepts of quantum computing
2	Illustrate building blocks of quantum computing through architecture and programming models.
3	Appraise various mathematical models required for quantum computing
4	Discuss various quantum hardware building principles.
5	Identify the various quantum algorithms
6	Describe usage of tools for quantum computing.

Module		Content	Hrs
1.0		Introduction to Quantum Computing	7
	1.1	Motivation for studying Quantum Computing Origin of Quantum Computing Quantum Computer vs. Classical Computer Introduction to Quantum mechanics Overview of major concepts in Quantum Computing	
	1.2	Qubits and multi-qubits states Bloch Sphere representation Quantum Superposition Quantum Entanglement Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.)	
2.0		Mathematical Foundations for Quantum Computing	05
	2.1	Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.	
3.0		Building Blocks for Quantum Program	08

	3.1	Architecture of a Quantum Computing platform Details of q-bit system of information representation: Block Sphere Multi-qubits States Quantum superposition of qubits (valid and invalid superposition) Quantum Entanglement Useful states from quantum algorithmic perceptive e.g. Bell State Operation on qubits: Measuring and transforming using gates. Quantum Logic gates and Circuit No Cloning Theorem and Teleportation	
	3.2	Programming model for a Quantum Computing Program Steps performed on classical computer Steps performed on Quantum Computer Moving data between bits and qubits.	
4.0		Quantum Algorithms and Error correction	06
	4.1	Quantum Algorithms, Shor's Algorithm, Grover's Algorithm. Deutsch's Algorithm, Deutsch -Jozsa Algorithm	
	4.2	Quantum error correction using repetition codes 3 qubit codes, Shor's 9 qubit error correction Code	
5.0		Quantum Hardware	10
	5.1	Ion Trap Qubits ,The DiVincenzo Criteria , Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating Rotor	
	5.2	Quantum Mechanics of a Free Rotor: A Poor Person's Atomic Model: Rotor Dynamics and the Hadamard Gate, Two-Qubit Gates	
	5.3	The Cirac-Zoller Mechanism: Quantum Theory of Simple Harmonic Motion, A Phonon-Qubit Pair Hamiltonian, Light-Induced Rotor-Phonon Interactions, Trapped Ion Qubits, Mølmer-Sørensen Coupling ..	
	5.4	Cavity Quantum Electrodynamics (cQED): Eigenstates of the Jaynes-Cummings Hamiltonian Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms, Superconducting Qubits Quantum computing with spins: Quantum inverter realized with two exchange coupled spins in quantum dots, A 2-qubit spintronic universal quantum gate.	
6.0		OSS Toolkits for implementing Quantum program	03
	6.1	IBM quantum experience Microsoft Q Rigetti PyQuil (QPU/QVM)	

Textbooks:	
1	Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press.
2	David McMahon, "Quantum Computing Explained", Wiley ,2008
3	Qiskit textbook https://qiskit.org/textbook-beta/
4	Vladimir Silva, Practical Quantum Computing for Developers,2018

References:	
1	Bernard Zygelman, A First Introduction to Quantum Computing and Information, 2018
2	Supriyo Bandopadhyay and Marc Cahy, “Introduction to Spintronics”, CRC Press, 2008
3	The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-Technologies, Lars Jaeger
4	La Guardia, Giuliano Gladioli “Quantum Error correction codes” Springer, 2021
Digital References:	
https://onlinecourses.nptel.ac.in/noc21_cs103/preview	
https://www.coursera.org/courses?query=quantum%20computing	
https://www.cl.cam.ac.uk/teaching/1617/QuantComp/	

<u>Assessment:</u>	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code	Course Name	Credit
CSDC7013	Natural Language Processing	03

Pre-requisite: Theory of Computer Science, System Programming & Compiler Construction

Course Objectives: The course aims

1	To define natural language processing and to learn various stages of natural language processing.
2	To describe basic concepts and algorithmic description of the main language levels: Morphology, Syntax, Semantics, and Pragmatics & Discourse analysis.
3	To design and implement various language models and POS tagging techniques.
4	To design and learn NLP applications such as Information Extraction, Question answering.
5	To design and implement applications based on natural language processing.

Course Outcomes: Students will be able

1	To describe the field of natural language processing.
2	To design language model for word level analysis for text processing.
3	To design various POS tagging techniques and parsers.
4	To design, implement and test algorithms for semantic and pragmatic analysis.
5	To formulate the discourse segmentation and anaphora resolution.
6	To apply NLP techniques to design real world NLP applications.

Module		Detailed Content	Hours
1	1.1	Introduction to NLP	3
		Origin & History of NLP; Language, Knowledge and Grammar in language processing; Stages in NLP; Ambiguities and its types in English and Indian Regional Languages; Challenges of NLP; Applications of NLP	
	1.2	Self-Learning topics: Variety types of tools for regional languages pre-processing and other functionalities	
2	2.1	Word Level Analysis	9
		Basic Terms: Tokenization, Stemming, Lemmatization; Survey of English Morphology, Inflectional Morphology, Derivational Morphology; Regular expression with types; Morphological Models: Dictionary lookup, finite state morphology; Morphological parsing with FST (Finite State Transducer); Lexicon free FST Porter Stemmer algorithm; Grams and its variation: Bigram, Trigram; Simple (Unsmoothed) N-grams; N-gram Sensitivity to the Training Corpus; Unknown Words: Open versus closed vocabulary tasks; Evaluating N-grams: Perplexity;	

		Smoothing: Laplace Smoothing, Good-Turing Discounting;	
	2.2	Self-Learning topics: Noisy channel models, various edit distance, Advance Issues in Language Modelling	
3	3.1	Syntax analysis	10
		Part-Of-Speech tagging(POS); Tag set for English (Upenn Treebank); Difficulties /Challenges in POS tagging; Rule-based, Stochastic and Transformation-based tagging; Generative Model: Hidden Markov Model (HMM Viterbi) for POS tagging; Issues in HMM POS tagging; Discriminative Model: Maximum Entropy model, Conditional random Field (CRF);Parsers: Top down and Bottom up; Modelling constituency; Bottom Up Parser: CYK, PCFG (Probabilistic Context Free Grammar), Shift Reduce Parser; Top Down Parser: Early Parser, Predictive Parser	
	3.2	Self-Learning topics: Evaluating parsers, Parsers based language modelling, Regional languages POS tree banks	
4	4.1	Semantic Analysis	7
		Introduction, meaning representation; Lexical Semantics; Corpus study; Study of Various language dictionaries like WorldNet, Babelnet; Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy; Semantic Ambiguity; Word Sense Disambiguation (WSD); Knowledge based approach(Lesk’s Algorithm), Supervised (Naïve Bayes, Decision List),Introduction to Semi-supervised method (Yarowsky) Unsupervised (Hyperlex)	
	4.2	Self-Learning topics: Dictionaries for regional languages, Distributional Semantics, Topic Models	
5	5.1	Pragmatic & Discourse Processing	5
		Discourse: Reference Resolution, Reference Phenomena, Syntactic & Semantic constraint on coherence; Anaphora Resolution using Hobbs and Canterling Algorithm	
	5.2	Self-Learning topics: Discourse segmentation, Conference resolution	
6	6.1	Applications of NLP	5
		Case studies on (preferable in regional language):Machine translation; Text Summarization; Sentiment analysis; Information retrieval; Question Answering system	
	6.2	Self-Learning topics: Applications based on Deep Neural Network with NLP such as LSTM network, Recurrent Neural network etc.	

Textbooks:	
1	Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Second Edition, Prentice Hall, 2008.
2	Christopher D.Manning and HinrichSchutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.
References:	
1	Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2	Daniel M Bikel and ImedZitouni — Multilingual natural language processing applications:

	from theory to practice, IBM Press, 2013.
3	Alexander Clark, Chris Fox, Shalom Lappin — The Handbook of Computational Linguistics and Natural Language Processing, John Wiley and Sons, 2012.
4	Nitin Indurkha and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.
5	Niel J le Roux and SugnetLubbe, A step by step tutorial: An introduction into R application and programming.
6	Steven Bird, Ewan Klein and Edward Loper, Natural language processing with Python: analyzing text with the natural language toolkit, O'Reilly Media, 2009.

Digital References :

1	http://www.cse.iitb.ac.in/~cs626-449
2	http://cse24-iiith.virtual-labs.ac.in/#
3.	https://nptel.ac.in/courses/106105158

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credit
CSDC7021	Augmented and Virtual Reality	03

Prerequisite: Computer Graphics	
Course Objectives: The course aims:	
1	To understand the need and significance of Virtual Reality.
2	To explore the concepts of Virtual reality and develop 3D virtual environments.
3	To understand the technical and engineering aspects of virtual reality systems.
4	To analyze various techniques for applying virtual reality.
5	To provide a foundation to the fast growing field of AR and make the students aware of the various AR devices.
Course Outcomes: Learners will be able to	
1:	Describe how VR systems work and list the applications of VR
2:	Elaborate geometric presentation of the virtual world and its operations.
3:	Explain the concepts of motion and tracking in VR systems.
4:	Design and implementation of the hardware that enables VR systems to be built.
5:	Describe how AR systems work and analyze the hardware requirement of AR
6:	Analyze and understand the working of various state of the art AR devices.

Module	Detailed Content	Hours
1	Introduction to Virtual Reality	5
	What is virtual reality? ,The beginnings of VR , VR paradigms , Collaboration, Virtual reality systems, Representation ,User interaction	
2	The Geometry of Virtual Worlds	6
	Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations	
3	Motion in Real and Virtual Worlds	6
	Velocities and Accelerations , The Vestibular System , Physics in the Virtual World , Mismatched Motion and Vection	
4	Applying Virtual Reality	7
	Virtual reality: the medium, Form and genre, What makes an application a good candidate for VR, Promising application fields, Demonstrated benefits of virtual reality , More recent trends in virtual reality application development, A framework for VR application development	
5	Augmented Reality	8
	Terminology, Simple augmented reality, Augmented reality as an emerging technology, Augmented reality applications, Marker detection, Marker pose, Marker types and identification: Template markers, 2D bar-code markers, Imperceptible markers: Image markers, Infrared markers, Miniature markers, Discussion on marker use, General marker detection application	
6	AR Development & Applications	

		User interfaces, Avoiding physical contacts , Practical experiences with head-mounted displays , Authoring and dynamic content ,AR applications and future visions, How to design an AR application ,Technology adoption and acceptance , Where to use augmented reality	

Textbooks:	
1	Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2	Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)”. Morgan Kaufmann Publishers, San Francisco, CA, 2002
3	Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig,William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.
4	Theory and applications of marker-based augmented reality SanniSiltanen
References:	
1	AR Game DevelopmentI, 1st Edition,Allan Fowler, A press Publications, 2018, ISBN 978-1484236178
2	Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
3	Learning Virtual Reality, Tony Parisi,O’Reilly Media, Inc., 2015, ISBN- 9781491922835

Digital Useful Links	
1	https://freevidelectures.com/course/3693/virtual-reality
2	https://www.vrlabacademy.com/
3	https://arvr.google.com/ar/
4	https://konterball.com/

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code:	Course Title	Credit
CSDC7022	Blockchain	3

Prerequisite: Cryptography and System Security

Course Objectives:

1	Understand blockchain platforms and its terminologies.
2	Understand the use of cryptography required for blockchain.
3	Understand smart contracts, wallets, and consensus protocols.
4	Design and develop blockchain applications

Course Outcomes:

1	Explain blockchain concepts.
2	Apply cryptographic hash required for blockchain.
3	Apply the concepts of smart contracts for an application.
4	Design a public blockchain using Ethereum.
5	Design a private blockchain using Hyperledger.
6	Use different types of tools for blockchain applications.

Module		Content	Hrs
1		Introduction to Blockchain	6
	1.1	What is a blockchain, Origin of blockchain (cryptographically secure hash functions), Foundation of blockchain: Merkle trees	
	1.2	Components of blockchain, Block in blockchain, Types: Public, Private, and Consortium, Consensus Protocol, Limitations and Challenges of blockchain	
2		Cryptocurrency	6
	2.1	Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security), Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage, Transactions in Blockchain, UTXO and double spending problem	
	2.2	Bitcoin blockchain: Consensus in Bitcoin, Proof-of-Work (PoW), Proof-of-Burn (PoB), Proof-of-Stake (PoS), and Proof-of-Elapsed Time (PoET), Life of a miner, Mining difficulty, Mining pool and its methods	
3		Programming for Blockchain	8
	3.1	Introduction to Smart Contracts, Types of Smart Contracts, Structure of a Smart Contract, Smart Contract Approaches, Limitations of Smart Contracts	
	3.2	Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling	
	3.3	Case Study – Voting Contract App, Preparing for smart contract development	

4		Public Blockchain	8
		Introduction to Public Blockchain, Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture and Workflow, Comparison between Bitcoin and Ethereum	
		Types of test-networks used in Ethereum, Transferring Ethers using Metamask, Mist Wallet, Ethereum frameworks, Case study of Ganache for Ethereum blockchain. Exploring etherscan.io and ether block structure	
5		Private Blockchain	8
	5.1	Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Replication, Consensus Algorithms for Private Blockchain - PAXOS and RAFT, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT	
	5.2	Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & Other Technologies	
	5.3	Hyperledger Fabric Architecture, Components of Hyperledger Fabric: MSP, Chain Codes, Transaction Flow, Working of Hyperledger Fabric, Creating Hyperledger Network, Case Study of Supply Chain Management using Hyperledger	
6		Tools and Applications of Blockchain	3
		Corda, Ripple, Quorum and other Emerging Blockchain Platforms, Blockchain in DeFi: Case Study on any of the Blockchain Platforms.	

Textbooks:

1	Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhillash K. A and Meena Karthikeyen, Universities Press.
2	Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3	Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Packt Publishing

References:

1	Blockchain for Beginners, Yathish R and Tejaswini N, SPD
2	Blockchain Basics, A non Technical Introduction in 25 Steps, Daniel Drescher, Apress.
3	Blockchain with Hyperledger Fabric, Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mention in the syllabus.

Digital Useful Links

1	Blockchain By Example, Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, November 2018, Implement decentralized blockchain applications to build scalable Dapps.
2	Blockchain for Business, https://www.ibm.com/downloads/cas/3EGWKGX7 .
3	https://www.hyperledger.org/use/fabric
4	NPTEL: https://onlinecourses.nptel.ac.in/noc19_cs63/preview

Course Code	Course Name	Credit
CSDC7023	Information Retrieval	03

Prerequisite: Data structures and algorithms	
Course Objectives: The course aims students :	
1	To learn the fundamentals of Information Retrieval
2	To analyze various Information retrieval modeling techniques
3	To understand query processing and its applications
4	To explore the various indexing and scoring techniques
5	To assess the various evaluation methods
6	To analyze various information retrieval for real world application
Course Outcomes: Learner will be able to: -	
1	Define and describe the basic concepts of the Information retrieval system.
2	Design the various modeling techniques for information retrieval systems.
3	Understand the query structure and various query operations
4	Analyzing the indexing and scoring operation in information retrieval systems
5	Perform the evaluation of information retrieval systems
6	Analyze various information retrieval for real world application

Module		Detailed Content	Hours
1		Introduction to Information Retrieval	4
	1.1	Introduction to Information Retrieval, Basic Concepts, Information Versus Data, Trends and research issues in information retrieval.	
	1.2	The retrieval process, Information retrieval in the library, web and digital libraries.	
2		Modeling in Information Retrieval	8
	2.1	Taxonomy of Information Retrieval models, Classic Information Retrieval, Alternate set: Theoretical model, Alternative Algebraic models, Alternative Probabilistic models	
	2.2	Structured text Retrieval models, Models for browsing	
3		Query and Operations in Information Retrieval	8
	3.1	Query structures, Keyboard based querying, Pattern matching, Structured queries	
	3.2	User relevance feedback, Automatic local analysis, Automatic global analysis	
4		Indexing and Scoring in Information Systems	8
	4.1	Introduction, Inverted Files, Other Indices for Text, Boolean queries and Introduction to Sequential searching	

	4.2	Scoring, term weighting and the vector space model, Parametric and zone indexes, Weighted zone scoring, Learning weights, The optimal weight, Term frequency and weighting, Inverse document frequency, Tf-idf weighting. The vector space model for scoring, Queries as vectors, Computing vector scores, Efficient scoring and ranking, Inexact top K document retrieval	
5		Evaluation of Information Retrieval Systems	
	5.1	Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing and justifying the concept of relevance	6
	5.2	System quality and user utility, System issues, Refining a deployed system	
6.		Applications of Information Retrieval Systems	
	6.1.	Introduction to Multimedia Information Retrieval	5
	6.2	Introduction to Distributed Information Retrieval	

Textbooks:	
1	Modern information retrieval, Baeza-Yates, R. and Ribeiro-Neto, B., 1999. ACM press.
2	Introduction to Information Retrieval By Christopher D. Manning and PrabhakarRaghavan, Cambridge University Press
3	Information Storage & Retrieval By Robert Korfhage – John Wiley & Sons
References:	
1	Storage Network Management and Retrieval, VaishaliKhairnar
2	Introduction to Modern Information Retrieval. G.G. Chowdhury. NealSchuman
3	Natural Language Processing and Information Retrieval by Tanveer Siddiqui, U.S Tiwarey

Useful Digital Links	
1	https://web.stanford.edu/class/cs276/
2	https://www.coursera.org/learn/text-retrieval

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
ILO 7011	Product Life Cycle Management	03

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to...

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Sr. No.	Detailed Contents	Hrs
01	Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05

05	Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment- A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO 7012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to...

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Sr. No	Detailed Contents	Hrs
01	Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillon, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Connor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO 7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to...

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Sr. No.	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO 7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to...

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Sr. No	Detailed Contents	Hrs
01	Introduction 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	Fitting Regression Models 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	Two-Level Factorial Designs 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	Two-Level Fractional Factorial Designs 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	Response Surface Methods and Designs 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface	07

	5.4 Experimental Designs for Fitting Response Surfaces	
06	Taguchi Approach 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO 7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to...

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Sr. No.	Detailed Contents	Hrs
01	Introduction to Operations Research: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	Queuing models: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	Simulation: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages	05

	of Simulation, Limitations of Simulation	
04	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Course Code	Course Name	Credits
ILO 7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to...

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Sr. No.	Detailed Contents	Hrs
01	Introduction to Cybercrime: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	Cyber offenses & Cybercrime: How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	Tools and Methods Used in Cyberline Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	The Concept of Cyberspace E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	Indian IT Act. Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	Information Security Standard compliances SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneth J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional : <https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

Course Code	Course Name	Credits
ILO 7017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to...

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Sr. No.	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.	06

	4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to...

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Sr. No	Detailed Contents	Hrs
01	Energy Scenario: Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	Energy Audit Principles: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	Energy Management and Energy Conservation in Electrical System: Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	Energy Management and Energy Conservation in Thermal Systems: Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery,	10

	use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	
05	Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Development Engineering	03

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to...

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Sr. No.	Module Contents	Hrs
01	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
02	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	04
03	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	06
04	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including	04

	social mobilization; Information Technology and rural planning; Need for further amendments.	
05	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	10
06	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

References:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission
New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Lab Code	Lab Name	Credit
CSL70011	Machine Learning Lab	1

Prerequisite: Data Structures, Analysis of Algorithms

Lab Objectives:

1	To introduce the basic concepts and techniques of Machine Learning.
2	To acquire in depth understanding of various supervised and unsupervised algorithms
3	To be able to apply various ensemble techniques for combining ML models.
4	To demonstrate dimensionality reduction techniques.

Lab Outcomes: At the end of the course, the students will be able to

1	To implement an appropriate machine learning model for the given application.
2	To implement ensemble techniques to combine predictions from different models.
3	To implement the dimensionality reduction techniques.

Suggested List of Experiments

Sr. No.	Title of Experiment
1	To implement Linear Regression.
2	To implement Logistic Regression.
3	To implement Ensemble learning (bagging/boosting)
4	To implement multivariate Linear Regression.
5	To implement SVM
6	To implement PCA/SVD/LDA
7	To implement Graph Based Clustering
8	To implement DB Scan
9	To implement CART
10	To implement LDA

Term Work:

1	Term work should consist of 6 experiments.
2	Journal must include one mini project/case study on any machine learning application.
3	The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments & Assignments: 15-marks, Attendance: 05-marks, mini project: 05-marks)

Oral & Practical exam.

Based on the entire syllabus **CSC7011** Machine Learning and **CSL7011**: Machine Learning Lab

Lab Code	Lab Name	Credit
CSL7012	Big Data Analytics Lab	1

Prerequisite: C Programming Language.

Lab Objectives: Students will be able to

- 1 Solve Big Data problems using Map Reduce Technique and apply to various algorithms.
- 2 Identify various types of NoSQL databases and execute NOSQL commands
- 3 Understand implementation of various analytic techniques using Hive/PIG/R/Tableau, etc.
- 4 Apply streaming analytics to real time applications.

Lab Outcomes:

- 1 To interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
- 2 To implement algorithms that uses Map Reduce to apply on structured and unstructured data
- 3 To perform hands-on NoSql databases such as Cassandra, HadoopHbase, MongoDB, etc.
- 4 To implement various data streams algorithms.
- 5 To develop and analyze the social network graphs with data visualization techniques.

Suggested List of Experiments

(Select a case study and perform the experiments 1 to 8.).

Star (*) marked experiments are compulsory.

Sr. No.	Name of the Experiment
1*	Hadoop HDFS Practical: -HDFS Basics, Hadoop Ecosystem Tools Overview. -Installing Hadoop. -Copying File to Hadoop. -Copy from Hadoop File system and deleting file. -Moving and displaying files in HDFS. -Programming exercises on Hadoop
2	Use of Sqoop tool to transfer data between Hadoop and relational database servers. a. Sqoop - Installation. b. To execute basic commands of Hadoop eco system componentSqoop.
3*	To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands
4	Experiment on Hadoop Map-Reduce: -Write a program to implement a word count program using MapReduce.
5	Experiment on Hadoop Map-Reduce: -Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc
6	Create HIVE Database and Descriptive analytics-basic statistics.
7*	Data Stream Algorithms (any one): - Implementing DGIM algorithm using any Programming Language - Implement Bloom Filter using any programming language Implement Flajolet Martin algorithm using any programming language
8	Social Network Analysis using R (for example: Community Detection Algorithm)
9	Data Visualization using Hive/PIG/R/Tableau/.
10	Exploratory Data Analysis using Spark/ Pyspark.

11*	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web). - Streaming data analysis – use flume for data capture, HIVE/PYSpark for analysis of twitter data, chat data, weblog analysis etc. - Recommendation System (for example: Health Care System, Stock Market Prediction, Movie Recommendation, etc.) SpatioTemporal DataAnalytics

Useful Links:

1	https://www.coursera.org/learn/hadoop#syllabus
2	https://www.coursera.org/learn/introduction-mongodb#syllabus
3	https://www.coursera.org/learn/data-visualization-tableau?specialization=data-visualization#syllabus
4	https://www.coursera.org/learn/introduction-to-big-data-with-spark-hadoop#syllabus

Term Work:

1	Term work should consist of 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignment: 05-marks)

Oral & Practical exam

	Based on the entire syllabus of and CSC702 : Big Data Analytics and CSL702 Big Data Analytics Lab

Lab Code	Lab Name	Credit
CSDL7011	Machine Vision Lab	1

Prerequisite: Computer Graphics, Image Processing, Python	
Lab Objectives:	
1	To perform basic image processing operations
2	To explore different preprocessing technique
3	To develop application related to Machine vision
4	To detect and recognize objects
Lab Outcomes:	
1	Students will be able to read image and video file, perform different processing
2	Students will be able to do edge detection ,depth estimation
3	Students will be able to choose appropriate algo for segmentation
4	Students will be able to implement object detection technique

Suggested Experiments: Students are required to complete at least 8 experiments.	
Sr.No.	Name of the Experiment
1	Handling Files, Cameras, and GUIs Basic I/O scripts ,Reading/writing an image file ,Converting between an image and raw bytes ,Accessing image data with numpy.array ,Reading/writing a video file ,Capturing camera frames, Displaying images in a window, Displaying camera frames in a window
2	Processing Images with OpenCV 3 Converting between different color spaces, The Fourier Transform, High pass filter, Low pass filter,
3	Edge detection with Canny, Contour detection, Contours – bounding box, minimum area rectangle, and minimum enclosing circle ,Contours – convex contours and the Douglas-Peucker algorithm ,Line and circle detection
4	Depth Estimation Capturing frames from a depth camera Creating a mask from a disparity map Masking a copy operation Depth estimation with a normal camera
5	Object segmentation using the Watershed and GrabCut algorithms Example of foreground detection with GrabCut Image segmentation with the Watershed algorithm
6	Detecting and Recognizing Faces Conceptualizing Haar cascades Getting Haar cascade data Using OpenCV to perform face detection Performing face detection on a still image
7	Performing face detection on video Performing face recognition Generating the data for face recognition Recognizing faces Preparing the training data Loading the data and recognizing faces

	Performing an Eigenfaces recognition
8	Retrieving Images and Searching Using Image Descriptors , Feature detection algorithms, Defining features Detecting features – corners Feature extraction and description using DoG and SIFT Anatomy of a keypoint
9	Detecting and Recognizing Objects Object detection and recognition techniques HOG descriptors The scale issue The location issue Non-maximum (or non-maxima) suppression Support vector machines People detection
10	Creating and training an object detector Bag-of-words BOW in computer vision Detecting cars in a scene

Reference & Useful Links:	
1	Learning OpenCV 3 Computer Vision with Python Second Edition, by Joe Minichino Joseph Howse Published by Packt Publishing Ltd.
2	http://iitk.ac.in/ee/computer-vision-lab
3	https://nptel.ac.in/courses/108103174
4	https://docs.opencv.org/3.4/d9/df8/tutorial_root.html

Term Work:	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Lab Code	Lab Name	Credit
CSDL7012	Quantum Computing Lab	1

Prerequisite: Python Programming Language.

Lab Objectives:

1	To implement fundamental quantum computing concepts
2	To learn quantum computation and quantum information
3	To understand quantum entanglement, quantum algorithms
4	To understand quantum information theory and channels

Lab Outcomes: Students will be able to

1	Implement basic quantum computing logic by building dice and random numbers using open source simulation tools.
2	Understand quantum logic gates using open source simulation tools.
3	Implement quantum circuits using open source simulation tools.
4	Implement quantum algorithms using open source simulation tools.

Suggested Experiments: Students are required to complete at least 10 experiments. Faculty may develop their own set of experiments for students. List below is only suggestive.

Sr. No.	Name of the Experiment
1	Building Quantum dice
2	Building Quantum Random No. Generation
3	Composing simple quantum circuits with q-gates and measuring the output into classical bits.
4	Implementation of Shor's Algorithms
5	Implementation of Grover's Algorithm
6	Implementation of Deutsch's Algorithm
7	Implementation of Deutsch-Jozsa's Algorithm
8	Quantum Circuits
9	Qubit Gates
10	Bell Circuit & GHZ Circuit
11	Accuracy of Quantum Phase Estimation
12	Mini Project such as implementing an API for efficient search using Grover's Algorithms or Integer factorization using Shor's Algorithm.

Useful Links:

1	IBM Experience: https://quantum-computing.ibm.com/
2	Microsoft Quantum Development Kit https://azure.microsoft.com/en-us/resources/development-kit/quantum-computing/#overview
3	Forest SDK PyQuil: https://pyquil-docs.rigetti.com/en/stable/
4	Google Quantum CIRQ https://quantumai.google/cirq
5	Qiskit Labs IBM https://learn.qiskit.org/course/ch-labs/lab-1-quantum-circuits

Term Work:

1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Lab Code	Lab Name	Credit
CSDL7013	Natural Language processing Lab	1

Prerequisite: Java/Python

Lab Objectives: The course aims

1	To understand the key concepts of NLP.
2	To learn various phases of NLP.
3	To design and implement various language models and POS tagging techniques.
4	To understand various NLP Algorithms
5	To learn NLP applications such as Information Extraction, Sentiment Analysis, Question answering, Machine translation etc.
6	To design and implement applications based on natural language processing

Lab Outcomes: Learners will be able

1	Apply various text processing techniques.
2	Design language model for word level analysis.
3	Model linguistic phenomena with formal grammar.
4	Design, implement and analyze NLP algorithms.
5	To apply NLP techniques to design real world NLP applications such as machine translation, sentiment analysis, text summarization, information extraction, Question Answering system etc.
6	Implement proper experimental methodology for training and evaluating empirical NLP systems.

Suggested List of Experiments

(Select a case study and perform the experiments 1 to 8.).

Star (*) marked experiments are compulsory.

Sr. No.	Name of the Experiment
1	Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, chat Bot, Plagiarism, Spelling & Grammar checkers, Sentiment / opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]
2	Apply various text preprocessing techniques for any given text : Tokenization and Filtration & Script Validation.
3	Apply various other text preprocessing techniques for any given text : Stop Word Removal, Lemmatization / Stemming.
4	Perform morphological analysis and word generation for any given text.
5	Implement N-Gram model for the given text input.
6	Study the different POS taggers and Perform POS tagging on the given text.
7	Perform Chunking for the given text input.
8	Implement Named Entity Recognizer for the given text input.
9	Implement Text Similarity Recognizer for the chosen text documents.

10	Exploratory data analysis of a given text (Word Cloud)
11	Mini Project Report: For any one chosen real world NLP application.
13	Implementation and Presentation of Mini Project

Term Work:

1	Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, chat Bot, Plagarism, Spelling & Grammar checkers, Sentiment / opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]
2	Apply various text preprocessing techniques for any given text: Tokenization and Filtration & Script Validation.
3	Apply various other text preprocessing techniques for any given text: Stop Word Removal, Lemmatization / Stemming.

Lab Code	Lab Name	Credit
CSDL7021	Augmented and Virtual Reality Lab	1

Prerequisite: Computer Graphics, Image Processing, Python	
Lab Objectives:	
1	To perform installation of Unity
2	To explore working of VR Gadget
3	To develop scene VR application
4	To track objects in virtual environment
Lab Outcomes: Learners will be able to	
1	Setup VR development environment
2	Use HTC Vive/ Google Cardboard/ Google Daydream and Samsung gear VR.
3	Develop VR scene and place object
4	Work with Augmented Faces features.

Suggested Experiments: Students are required to complete at least 6 experiments.	
Sr. No.	Name of the Experiment
1	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2	Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
3	Develop a scene in Unity that includes: i. a cube, plane and sphere, apply transformations on the 3 game objects. ii. add a video and audio source
4	Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the colour, material and texture of each Game object separately in the scene. Write a C# program in visual studio to change the colour and material/texture of the game objects dynamically on button click.
5	Develop a scene in Unity that includes a sphere and plane . Apply Rigid body component, material and Box collider to the game Objects. Write a C# program to grab and throw the sphere using vr controller.
6	Develop a simple UI(User interface) menu with images, canvas, sprites and button. Write a C# program to interact with UI menu through VR trigger button such that on each successful trigger interaction display a score on scene .
7	Place a three-dimensional ARCore pawn on detected AR plane surfaces
8	Using the Augmented Faces feature in your own apps.

Term Work:	
1	Term work should consist of 6 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Lab Code	Lab Name	Credit
CSDL7022	Blockchain Lab	1

Prerequisite: Cryptography and Network Security

Lab Objectives:

1	To explore Blockchain concepts.
2	To implement public and private Blockchain.
3	To create applications using Blockchain.

Lab Outcomes: At the end of the course, the students will be able to

1	Creating Cryptographic hash using merkle tree.
2	Design Smart Contract using Solidity.
3	Implementing ethereum blockchain using Geth.
4	Demonstrate the concept of blockchain in real world application.

Suggested List of Experiments

Sr. No.	Title of Experiment
1	Cryptography in Blockchain, Merkle root tree hash
2	Creating Smart Contract using Solidity and Remix IDE.
3	Creating Transactions using Solidity and Remix IDE
4	Embedding wallet and transaction using Solidity
5	Blockchain platform ethereum using Geth.
6	Blockchain platform Ganache.
7	Case Study on Hyperledger
8	Case Study on Other Blockchain platforms.
9	Creating a blockchain Application

Term Work:

1	Term work should consist of 8 experiments and one mini project.
2	Journal must include at least 2 assignments on content of theory and practical of “Blockchain Lab”
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Lab Code	Lab Name	Credit
CSDL7023	Information Retrieval Lab	1

Prerequisite: Java, Python

Lab Objectives:

1	To understand the formation of queries.
2	To implement the various modeling techniques for IR.
3	To execute query expansion techniques.
4	To evaluate Information retrieval systems.

Lab Outcomes: Students will be able :-

1	To frame queries for information retrieval
2	To implement modeling techniques
3	To perform query expansion techniques
4	To demonstrate evaluation techniques for IR

Suggested Experiments: Students are required to perform any **5 experiments** from the suggested list along with **a case study** (* indicates compulsory experiment)

Sr. No.	Name of the Experiment
1	To understand the query structure and execute various structured queries
2	To implement any IR modeling technique
3	To implement Pattern matching method used for IR
4	To execute query expansion technique (Local/Global)
5	To design inverted indices for any information retrieval model
6	To implement tf-id weighting
7	To evaluate the system/application under study
8*	To understand the Case Study and generate a report for the same

Term Work:

1	Term work should consist of 5 experiments and 1 case study
2	Journal must include at least 2 assignments .
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total: 25 Marks (Experiments: 10-marks, Case study - 5 marks Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Course Code	Course Name	Credit
CSP701	Major Project 1	03

Course Objectives:	
The project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions.	
Course Outcomes: Learner will able	
1	To develop the understanding of the problem domain through extensive review of literature.
2	To Identify and analyze the problem in detail to define its scope with problem specific data.
3	To know various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4	To design solutions for real-time problems that will positively impact society and environment..
5	To develop clarity of presentation based on communication, teamwork and leadership skills.
6	To inculcate professional and ethical behavior.

Guidelines:

1. Project Topic Selection and Allocation:

- Project topic selection Process to be defined and followed:
 - Project orientation can be given at the end of sixth semester.
 - Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
 - Student's should be recommended to refer papers from reputed conferences/journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
 - Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements. Students can be informed to refer Digital India portal, SIH portal or any other hackathon portal for problem selection.
- Topics can be finalized with respect to following criterion:
 - **Topic Selection:** The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.
 - **Technology Used:** Use of latest technology or modern tools can be encouraged.
 - Students should not repeat work done previously (work done in the last three years).

- Project work must be carried out by the group of at least 2 students and maximum 4.
- The project work can be undertaken in a research institute or organization/Industry/any business establishment. (out-house projects)
- The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are expert in the domain.
- Head of department and senior staff along with project coordinators will take decision regarding final selection of projects.
- Guide allocation should be done and students have to submit weekly progress report to the internal guide.
- Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.
- In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels

2. Project Report Format:

At the end of semester, each group needs to prepare a project report as per the guidelines issued by the University of Mumbai.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey/ Existing system
- Limitation Existing system or research gap
- Problem Statement and Objective
- Proposed System
 - Analysis/Framework/ Algorithm
 - Design details
 - Methodology (your approach to solve the problem) Proposed System
- Experimental Set up
 - Details of Database or details about input to systems or selected data
 - Performance Evaluation Parameters (for Validation)
 - Software and Hardware Set up
- Implementation Plan for Next Semester
 - Timeline Chart for Term1 and Term-II (Project Management tools can be used.)
- References

Desirable

Students can be asked to undergo some Certification course (for the technical skill set that will be useful and applicable for projects.)

3. Term Work:

Distribution of marks for term work shall be done based on following:

- Weekly Log Report
- Project Work Contribution
- Project Report (Spiral Bound) (both side print)
- Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. Oral and Practical:

Oral and Practical examination (Final Project Evaluation) of Project 1 should be conducted by Internal and External examiners approved by University of Mumbai at the end of the semester.

Suggested quality evaluation parameters are as follows:

- Quality of problem selected
- Clarity of problem definition and feasibility of problem solution
- Relevance to the specialization / industrial trends
- Originality
- Clarity of objective and scope
- Quality of analysis and design
- Quality of written and oral presentation
- Individual as well as team work

Course Code:	Course Title	Credit
CSC801	Distributed Computing	3

Prerequisite: Computer Networks and Operating Systems.

Course Objectives:

1	To provide students with contemporary knowledge in distributed systems.
2	To explore the various methods used for communication in distributed systems.
3	To provide skills to measure the performance of distributed synchronization algorithms.
4	To provide knowledge of resource management, and process management including process migration.
5	To learn issues involved in replication, consistency, and file management.
6	To equip students with skills to analyze and design distributed applications.

Course Outcomes: At the end of the course students will be able to

1	Demonstrate the knowledge of basic elements and concepts related to distributed system technologies.
2	Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object-based middleware.
3	Analyze the various techniques used for clock synchronization, mutual exclusion and deadlock.
4	Demonstrate the concepts of Resource and Process management.
5	Demonstrate the concepts of Consistency, Replication Management and fault Tolerance.
6	Apply the knowledge of Distributed File systems in building large-scale distributed applications.

Module	Content	Hrs
1	Introduction to Distributed Systems	4
1.1	Characterization of Distributed Systems: Issues, Goals, Types of distributed systems, Grid and Cluster computing Models, Hardware and Software Concepts: NOS, DOS.	
1.2	Middleware: Models of middleware, Services offered by middleware.	
2	Communication	4
2.1	Interprocess communication (IPC): Remote Procedure Call (RPC), Remote Method Invocation (RMI).	
2.2	Message-Oriented Communication, Stream Oriented Communication, Group Communication.	
3	Synchronization	10
3.1	Clock Synchronization: Physical clock, Logical Clocks, Election Algorithms	
3.2	Distributed Mutual Exclusion, Requirements of Mutual Exclusion Algorithms and Performance measures. Non- token Based Algorithms: Lamport, Ricart–Agrawala’s and Maekawa’s Algorithms; Token-based Algorithms: Suzuki-Kasami’s Broadcast Algorithms and Raymond’s Tree-based Algorithm; and Comparative Performance Analysis.	

3.3	Deadlock: Introduction, Deadlock Detection: Centralized approach, Chandy - Misra_Hass Algorithm.	
4	Resource and Process Management	7
4.1	Desirable Features of Global Scheduling algorithm, Task assignment approach, Load balancing approach and load sharing approach.	
4.2	Introduction to Process Management, Process Migration, Code Migration.	
5	Replication, Consistency and Fault Tolerance	
5.1	Distributed Shared Memory: Architecture, design issues.	8
5.2	Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management.	
5.3	Fault Tolerance: Introduction, Process resilience, Recovery.	
6	Distributed File Systems	6
6.1	Introduction and features of DFS, File models, File Accessing models, File-Caching Schemes, File Replication, Case Study: Network File System (NFS).	
6.2	Designing Distributed Systems: Google Case Study.	

Textbooks:

1	Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2	Mukesh Singhal, Niranjana G. Shivaratri, "Advanced concepts in operating systems: Distributed, Database and multiprocessor operating systems", MC Graw Hill education.
3	Pradeep K. Sinha, "Distributed Operating System-Concepts and design", PHI.

References:

1	M. L. Liu, —Distributed Computing Principles and Applications, Pearson Addison Wesley, 2004
2	George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005.

Useful Links

1	https://nptel.ac.in/courses/106106107
2	https://nptel.ac.in/courses/106106168
3	http://csis.pace.edu/~marchese/CS865/Lectures/Chap7/Chapter7fin.htm
4	https://nptel.ac.in/courses/106104182

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and the second-class test when an additional 40% syllabus is completed. The duration of each test shall be one hour.

End Semester Theory Examination:

1	The question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only four questions need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code:	Course Title	Credit
CSDC8011	Deep Learning	3

Prerequisite: Basic mathematics and Statistical concepts, Linear algebra, Machine Learning

Course Objectives:

1	To learn the fundamentals of Neural Network.
2	To gain an in-depth understanding of training Deep Neural Networks.
3	To acquire knowledge of advanced concepts of Convolution Neural Networks, Autoencoders and Recurrent Neural Networks.
4	Students should be familiar with the recent trends in Deep Learning.

Course Outcomes:

1	Gain basic knowledge of Neural Networks.
2	Acquire in depth understanding of training Deep Neural Networks.
3	Design appropriate DNN model for supervised, unsupervised and sequence learning applications.
4	Gain familiarity with recent trends and applications of Deep Learning.

Module		Content	39Hrs
1		Fundamentals of Neural Network	4
	1.1	Biological neuron, Mc-Culloch Pitts Neuron, Perceptron, Perceptron Learning, Delta learning, Multilayer Perceptron: Linearly separable, linearly non-separable classes	
	1.2	Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning	
2		Training, Optimization and Regularization of Deep Neural Network	10
	2.1	Training Feedforward DNN Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function	
	2.2	Optimization Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp	
	2.3	Regularization Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output	
3		Autoencoders: Unsupervised Learning	6
	3.1	Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders	

	3.2	Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders	
	3.3	Application of Autoencoders: Image Compression	
4		Convolutional Neural Networks (CNN): Supervised Learning	7
	4.1	Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function	
	4.2	Modern Deep Learning Architectures: LeNET: Architecture, AlexNET: Architecture	
5		Recurrent Neural Networks (RNN)	8
	5.1	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT	
	5.2	Long Short Term Memory: Selective Read, Selective write, Selective Forget, Gated Recurrent Unit	
6		Recent Trends and Applications	4
	6.1	Generative Adversarial Network (GAN): Architecture	
	6.2	Applications: Image Generation, DeepFake	

Textbooks:	
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville. “Deep Learning”, MIT Press Ltd, 2016
2	Li Deng and Dong Yu, “Deep Learning Methods and Applications”, Publishers Inc.
3	Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4	JM Zurada “Introduction to Artificial Neural Systems”, Jaico Publishing House
5	M. J. Kochenderfer, Tim A. Wheeler. “Algorithms for Optimization”, MIT Press.
References:	
1	Buduma, N. and Locascio, N., “Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc."
2	François Chollet. “Deep learning with Python “(Vol. 361). 2018 New York: Manning.
3	Douwe Osinga. “Deep Learning Cookbook”, O'REILLY, SPD Publishers, Delhi.
4	Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc
5	S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India

<u>Assessment:</u>	
Internal Assessment:	
The assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All questions carry equal marks.
3	Question 1 and question 6 will have questions from all modules. Remaining 4 questions will be based on the remaining 4 modules.
4	Only four questions need to be solved.

5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
2	http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3	https://nptel.ac.in/courses/106/106/106106184/
4	https://www.deeplearningbook.org/

Course Code:	Course Title	Credit
CSDC8012	Digital Forensics	3

Prerequisite: Computer Network, Cryptography and System Security

Course Objectives:

1	To discuss the need and process of digital forensics and Incident Response Methodology.
2	To explore the procedures for identification, preservation, and acquisition of digital evidence.
3	To explore techniques and tools used in digital forensics for Operating system and malware investigation .
4	To explore techniques and tools used for Mobile forensics and browser, email forensics

Course Outcomes:

1	Discuss the phases of Digital Forensics and methodology to handle the computer security incident.
2	Describe the process of collection, analysis and recovery of the digital evidence.
3	Explore various tools to analyze malwares and acquired images of RAM/hard drive.
4	Acquire adequate perspectives of digital forensic investigation in mobile devices
5	Analyze the source and content authentication of emails and browsers.
6	Produce unambiguous investigation reports which offer valid conclusions.

Module		Content	Hrs
1		Introduction to Digital Forensics	6
	1.1	Digital Forensics Definition, Digital Forensics Goals, Digital Forensics Categories - Computer Forensics, Mobile Forensics, Network Forensics, Database Forensics	
	1.2	Introduction to Incident - Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phase after detection of an incident	
2		Digital Evidence, Forensics Duplication and Digital Evidence Acquisition	9
	2.1	Digital evidence, Types of Digital Evidence, Challenges in acquiring Digital evidence, Admissibility of evidence, Challenges in evidence handling, Chain of Custody	
	2.2	Digital Forensics Examination Process - Seizure, Acquisition, Analysis, Reporting. Necessity of forensic duplication, Forensic image formats, Forensic duplication techniques,.	
	2.3	Acquiring Digital Evidence - Forensic Image File Format, Acquiring Volatile Memory (Live Acquisition), Acquiring Nonvolatile Memory (Static Acquisition), Hard Drive Imaging Risks and Challenges, Network Acquisition	
3		Forensics Investigation	4
	3.1	Analyzing Hard Drive Forensic Images, Analyzing RAM Forensic Image, Investigating Routers	
	3.2	Malware Analysis - Malware, Viruses, Worms, Essential skills and tools for Malware Analysis, List of Malware Analysis Tools and	

		Techniques	
4		Windows and Unix Forensics Investigation	8
	4.1	Investigating Windows Systems - File Recovery, Windows Recycle Bin Forensics, Data Carving, Windows Registry Analysis, USB Device Forensics, File Format Identification, Windows Features Forensics Analysis, Windows 10 Forensics, Cortana Forensics	
	4.2	Investigating Unix Systems - Reviewing Pertinent Logs, Performing Keyword Searches, Reviewing Relevant Files, Identifying Unauthorized User Accounts or Groups, Identifying Rogue Processes, Checking for Unauthorized Access Points, Analyzing Trust Relationships	
5		Mobile Forensics	8
	5.1	Android Forensics, Mobile Device Forensic Investigation - Storage location, Acquisition methods, Data Analysis	
	5.2	GPS forensics - GPS Evidentiary data, GPS Exchange Format (GPX), GPX Files, Extraction of Waypoints and TrackPoints, Display the Tracks on a Map.	
	5.3	SIM Cards Forensics - The Subscriber Identification Module (SIM), SIM Architecture, Security, Evidence Extraction.	
6		Browser, Email Forensic & Forensic Investigation Reporting	4
	6.1	Web Browser Forensics, Google chrome, Other web browser investigation Email forensics - Sender Policy Framework (SPF), Domain Key Identified Mail (DKIM), Domain based Message Authentication Reporting and Confirmation (DMARC)	
	6.2	Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report	

Textbooks:

1	Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGrawHill, 2006
2	Digital Forensics Basics A Practical Guide Using Windows OS — Nihad A. Hassan, APress Publication, 2019
3	Xiaodong Lin, "Introductory Computer Forensics: A Hands-on Practical Approach", Springer Nature, 2018

Suggested MOOC Course Links

1	Course on "Ethical Hacking" https://nptel.ac.in/courses/106/105/106105217/
2	Course on "Digital Forensics" https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
3	Course on Cyber Incident Response https://www.coursera.org/learn/incident-response
4	Course on "Penetration Testing, Incident Responses and Forensics" https://www.coursera.org/learn/ibm-penetration-testing-incident-response-forensics

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mention in the syllabus.

Course Code	Course Name	Credit
CSDC8013	Applied Data Science	03

Prerequisite: Machine Learning, Data Structures & Algorithms

Course Objectives:

1	To introduce students to the basic concepts of data science.
2	To acquire an in-depth understanding of data exploration and data visualization.
3	To be familiar with various anomaly detection techniques.
4	To understand the data science techniques for different applications.

Course Outcomes:

1	To gain fundamental knowledge of the data science process.
2	To apply data exploration and visualization techniques.
3	To apply anomaly detection techniques.
4	To gain an in-depth understanding of time-series forecasting.
5	Apply different methodologies and evaluation strategies.
6	To apply data science techniques to real world applications.

Module		Detailed Content	Hours
1		Introduction to Data Science	2
	1.1	Introduction to Data Science, Data Science Process	
	1.2	Motivation to use Data Science Techniques: Volume, Dimensions and Complexity, Data Science Tasks and Examples	
	1.3	Overview of Data Preparation, Modeling, Difference between data science and data analytics	
2		Data Exploration	8
	2.1	Types of data, Properties of data Descriptive Statistics: Univariate Exploration: Measure of Central Tendency, Measure of Spread, Symmetry, Skewness: Karl Pearson Coefficient of skewness, Bowley's Coefficient, Kurtosis Multivariate Exploration: Central Data Point, Correlation, Different forms of correlation, Karl Pearson Correlation Coefficient for bivariate distribution	

	2.2	Inferential Statistics: Overview of Various forms of distributions: Normal, Poisson, Test Hypothesis, Central limit theorem, Confidence Interval, Z-test, t-test, Type-I, Type-II Errors, ANOVA	
3		Methodology and Data Visualization	06
	3.1	Methodology: Overview of model building, Cross Validation, K-fold cross validation, leave-1 out, Bootstrapping	
	3.2	Data Visualization Univariate Visualization: Histogram, Quartile, Distribution Chart Multivariate Visualization: Scatter Plot, Scatter Matrix, Bubble chart, Density Chart Roadmap for Data Exploration	
	3.3	Self-Learning Topics: Visualizing high dimensional data: Parallel chart, Deviation chart, Andrews Curves.	
4		Anomaly Detection	06
	4.1	Outliers, Causes of Outliers, Anomaly detection techniques, Outlier Detection using Statistics	
	4.2	Outlier Detection using Distance based method, Outlier detection using density-based methods, SMOTE	
5		Time Series Forecasting	4
	5.1	Taxonomy of Time Series Forecasting methods, Time Series Decomposition	
	5.2	Smoothing Methods: Average method, Moving Average smoothing, Time series analysis using linear regression, ARIMA Model, Performance Evaluation: Mean Absolute Error, Root Mean Square Error, Mean Absolute Percentage Error, Mean Absolute Scaled Error	
	5.3	Self-Learning Topics: Evaluation parameters for Classification, regression and clustering.	
6		Applications of Data Science	4
		Predictive Modeling: House price prediction, Fraud Detection Clustering: Customer Segmentation Time series forecasting: Weather Forecasting Recommendation engines: Product recommendation	

Textbooks:	
1	Vijay Kotu, Bala Deshpande. “Data Science Concepts and Practice”, Elsevier, M.K. Publishers.
2	Steven Skiena, “Data Science Design Manual”, Springer International Publishing AG
3	Samir Madhavan. “Mastering Python for Data Science”, PACKT Publishing
4	Dr. P. N. Arora, Sumeet Arora, S. Arora, Ameet Arora, “Comprehensive Statistical Methods”, S.Chand Publications, New Delhi.

References:

1	Jake VanderPlas. “Python Data Science Handbook”, O’reilly Publications.
2	Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor, “Recommender Systems Handbook”, Springer.
3	S.C. Gupta, V. K. Kapoor “Fundamentals of Mathematical Statistics”, S. Chand and Sons, New Delhi.
4	B. L. Agrawal. “Basic Statistics”, New Age Publications, Delhi.

Useful Links

1	https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs69/preview

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise a total of six questions.
2	All questions carry equal marks.
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4	Only Four questions need to be solved.

Course Code:	Course Title	Credit
CSDC8021	Optimization in Machine Learning	3

Prerequisite: Engineering Mathematics, Algorithms and data structures
Course Objectives:
1. Understand, analyze and apply existing derivative based optimization algorithms
2. Analyze and apply stochastic methods in optimization
3. Analyze convex optimization for machine learning problems
4. Understand real life problems and apply evolutionary methods to optimize them
Course Outcomes:
1. To understand foundational optimization ideas including gradient descent, stochastic gradient methods
2. To apply convex optimization algorithm
3. To analyze and demonstrate several population methods in Evolutionary Computation
4. To apply advanced evolutionary algorithms such as particle swarm and ant colony optimization

Module		Content	Hrs
1		Introduction and Background to Optimization Theory	4
	1.1	Basic Ingredients of Optimization Problems, Optimization Problem Classifications, Optima Types, Optimization Method Classes, Overview of Unconstrained and Constrained Optimization, Basics of convex optimization	
2		Derivative based Optimization	10
	2.1	The Basics of Optimization (univariate, bivariate and multivariate optimization), Convex Objective Functions	
	2.2	First-Order optimization Methods : Gradient Descent, Conjugate Gradient, Momentum, Nesterov Momentum, Adagrad, RMSProp, learning rate optimization	
	2.3	Second order optimization: Newton method	
3		Stochastic Methods	6
		Noisy Descent, Mesh Adaptive Direct Search, Cross-Entropy Method, Natural Evolution Strategies, Covariance Matrix Adaptation	
4		Convex Optimization	6
		Optimization problems, Convex optimization, Linear optimization problems, Quadratic optimization problems,	

		Geometric programming, Overview of Generalized inequality constraints and Vector optimization	
5		Evolutionary Methods	8
	5.1	Introduction to Evolutionary Computation: Generic Evolutionary Algorithm, Representation: The Chromosome, Initial Population, Fitness Function, Selection: Selective Pressure, Random Selection, Proportional Selection, Tournament Selection, Rank-Based Selection, Elitism and Evolutionary Computation versus Classical Optimization, Stopping conditions	
	5.2	Canonical Genetic Algorithm, Binary Representations of Crossover and Mutation: Binary Representations, Control Parameters	
6		Advance Evolutionary Methods	5
	6.1	Basic Particle Swarm Optimization, Global Best PSO, Local Best PSO, g-best versus l-best PSO, Velocity Components, Geometric Illustration, Algorithm Aspects, Social Network Structures	
	6.2	Ant Colony Optimization Meta-Heuristic, Foraging Behavior of Ants, Stigmergy and Artificial Pheromone, Simple Ant Colony Optimization, Ant System, Ant Colony System	

Textbooks:	
1	Mykel J. Kochenderfer, Tim A. Wheeler, Algorithms for Optimization, MIT Press (2019)
2	Andries P Engelbrecht, Computational Intelligence-An Introduction, Second-Edition, Wiley publication
3	Charu C. Aggarwal, Linear Algebra and Optimization for Machine Learning, , Springer ,2020.
References:	
1	Suvrit Sra, Sebastian Nowozin, Stephen J. Wright, Optimization for Machine Learning, The MIT Press
2	Xin-She Yang Middlesex ,Optimization techniques and applications with examples, Wiley
3	A.E. Eiben, J. E. Smith, Introduction to Evolutionary Computing, Springer

Useful Links	
1	<u>Convex optimization (NPTEL)</u>
2	<u>Constrained and Unconstrained optimization (NPTEL)</u>
3	<u>Machine-learning-model-performance (Coursera)</u>
4	<u>Deep-neural-network optimization (Coursera)</u>

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise a total of six questions.
2	All questions carry equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Course Code:	Course Title	Credit
CSDC8022	High Performance Computing	3

Prerequisite: Computer Architecture, Operating System, Cloud Computing	
Course Objectives: The objective of the course is to	
1	Introduce the fundamental concepts of high-performance computing (HPC) architecture and parallel computing.
2	Provide foundations for developing, analyzing, and implementing parallel algorithms using parallelization paradigms like MPI, OpenMP, OpenCL, and CUDA.
3	Introduce range of activities associated with HPC in Cloud
Course Outcomes: After learning the course, the students will be able to:	
1	Understand parallel and pipeline processing approaches
2	Design a parallel algorithm to solve computational problems and identify issues in parallel programming.
3	Analyze the performance of parallel computing systems for clusters in terms of execution time, total parallel overhead, speedup.
4	Develop efficient and high-performance parallel algorithms using OpenMP and message passing paradigm
5	Develop high-performance parallel programming using OpenCL and CUDA framework
6	Perform the range of activities associated with High Performance Computing in Cloud Computing

Module		Content	Hrs
1		Introduction to Parallel Computing	5
	1.1	Parallelism (What, Why, Applications), Levels of parallelism(instruction, transaction, task, thread, memory, function)	
	1.2	Classification Models: Architectural Schemes(Flynn's, Shore's, Feng's, Handler's)	
	1.3	Memory Access: Distributed Memory, Shared Memory, Hybrid Distributed Shared Memory	
	1.4	Parallel Architecture: Pipeline Architecture: Arithmetic pipelines, Floating Point, Array Processor	
2		Parallel Programming Platform and Algorithm Design	11
	2.1	Parallel Programming Platform: Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines	
	2.2	Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.	
3		Performance Measures	3
		Performance Measures: Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Amdahl's Law, Gustavson's Law, Performance Bottlenecks, The Karp Flatt Metric.	
4		HPC Programming: OpenMP and MPI	10

	HPC Programming: OpenMP 4.1 Introduction: Threads, Share memory Architecture, Multi-core processors and Hyperthreading, Fork and join model. 4.2 OpenMP directives: #pragma omp parallel, Hello world with openMP, #pragma omp for, #pragma omp for schedule.Serial vs Parallel PI program. 4.3 Synchronisation: Introduction, Private vs Shared variables. Critical section, #pragma omp critical, #pragma omp atomic, #pragma omp barrier, #pragma omp reduction HPC Programming: MPI 4.4 Introduction: Processes, Multiprocessor programming model, Distributed system programming model, Inter-process communication using message passing: Asynchronous and Synchronous 4.5 MPI Programming: Hello world problem, mpi_initMPI_sendMPI_Recv, Synchronisation: MPI_Barrier 4.6 Hybrid (MPI + OpenMP) programming, Hardware requirement, Threads inside Processes, Hybrid Matrix multiplication 4.7 Message passing vs Share memory communication: Advantages and disadvantage	
5	Parallel programming using accelerators	4
	An Overview of GPGPUs, Introduction to CUDA, Introduction to Heterogeneous Computing using OpenCL, An Overview of OpenCL API, Heterogeneous Programming in OpenCL.	
6	High Performance Computing in the Cloud	4
	Virtualization and Containerization, Parallel Computing Frameworks, Scaling, HPC in the Cloud Use Cases.	

Textbooks:	
1	AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar “Introduction to Parallel Computing”, 2nd edition, Addison Wesley, 2003.
2	Shane Cook, Morgan Kaufmann “CUDA Programming: A Developer's Guide to Parallel Computing with GPUs”, 2012.
3	M. R. Bhujade “Parallel Computing”,2nd edition, New Age International Publishers, 2009.
4	Kai Hwang, Naresh Jotwani, “Advanced Computer Architecture: Parallelism, Scalability, Programmability” McGraw Hill, Second Edition, 2010.
5	Georg Hager, Gerhard Wellein, Chapman “Introduction to High Performance Computing for Scientists and Engineers” Hall/CRC Computational Science Series, 2011.
References:	
1	Michael J. Quinn “Parallel Programming in C with MPI and OpenMPI” by, McGraw Hill Education, 2008.
2	Kai Hwang ,Zhiwei, “Scalable Parallel Computing: Technology, Architecture, Programming”, McGraw-Hill Education, 1998.
3	Laurence T. Yang, Minyi Guo, “High-Performance Computing: Paradigm and Infrastructure”, by, Wiley, 2006.

Useful Links	
1	https://nptel.ac.in/courses/112105293
2	https://archive.nptel.ac.in/courses/128/106/128106014/

<u>Assessment:</u>	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Course Code	Course Name	Credit
CSDC8023	Social Media Analytics	03

Prerequisite: Graph Theory, Data Mining, Python/R programming	
Course Objectives: The course aims:	
1	Familiarize the learners with the concept of social media.
2	Familiarize the learners with the concept of social media analytics and understand its significance.
3	Enable the learners to develop skills required for analyzing the effectiveness of social media.
4	Familiarize the learners with different tools of social media analytics.
5	Familiarize the learner with different visualization techniques for Social media analytics.
6	Examine the ethical and legal implications of leveraging social media data.
Course Outcomes:	
1	Understand the concept of Social media
2	Understand the concept of social media Analytics and its significance.
3	Learners will be able to analyze the effectiveness of social media
4	Learners will be able to use different Social media analytics tools effectively and efficiently.
5	Learners will be able to use different effective Visualization techniques to represent social media analytics.
6	Acquire the fundamental perspectives and hands-on skills needed to work with social media data.

Module	Detailed Content	Hours
1.	Social Media Analytics: An Overview	
	Core Characteristics of Social Media, Types of Social Media, Social media landscape, Need for Social Media Analytics (SMA), SMA in small & large organizations. Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools	6
2.	Social Network Structure, Measures & Visualization	
	Basics of Social Network Structure - Nodes, Edges & Tie Describing the Networks Measures - Degree Distribution, Density, Connectivity, Centralization, Tie Strength & Trust Network Visualization - Graph Layout, Visualizing Network features, Scale Issues. Social Media Network Analytics - Common Network Terms, Common Social Media Network Types, Types of Networks, Common Network Terminologies, Network Analytics Tools.	6
3.	Social Media Text, Action & Hyperlink Analytics	
	Social Media Text Analytics - Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text	8

	Analysis Tools Social Media Action Analytics - What Is Actions Analytics? Common Social Media Actions, Actions Analytics Tools Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics, Hyperlink Analytics Tools	
4.	Social Media Location & Search Engine Analytics	
	Location Analytics - Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools Search Engine Analytics - Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools	6
5.	Social Information Filtering	
	Social Information Filtering - Social Sharing and filtering , Automated Recommendation systems, Traditional Vs social Recommendation Systems Understanding Social Media and Business Alignment, Social Media KPI, Formulating a Social Media Strategy, Managing Social Media Risks	6
6.	Social Media Analytics Applications and Privacy	
	Social media in public sector - Analyzing public sector social media, analyzing individual users, case study. Business use of Social Media - Measuring success, Interaction and monitoring, case study. Privacy - Privacy policies, data ownership and maintaining privacy online.	7

Textbooks:	
1.	Seven Layers of Social Media Analytics_ Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data, Gohar F. Khan,(ISBN-10: 1507823207).
2.	Analyzing the Social Web 1st Edition by Jennifer Golbeck
3.	Mining the Social Web_ Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites, Matthew A Russell, O'Reilly
4	Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011
References:	
1.	Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, AvinashKohirkar, IBM Press
2.	Social Media Analytics Strategy_ Using Data to Optimize Business Performance, Alex Gonçalves, APress Business Team
3.	Social Media Data Mining and Analytics, Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulos (2019), Wiley, ISBN 978-1-118-82485-6

Useful Links	
1	https://cse.iitkgp.ac.in/~pawang/courses/SC16.html
2	https://onlinecourses.nptel.ac.in/noc20_cs78/preview
3	https://nptel.ac.in/courses/106106146
4	https://7layersanalytics.com/

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Credits
ILO 8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to...

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	5
02	Initiating Projects: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	8
04	Planning Projects: Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	5.1 Executing Projects: Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings 5.2 Monitoring and Controlling Projects:	8

	Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit 5.3 Project Contracting Project procurement management, contracting and outsourcing,	
06	6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects 6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

REFERENCES:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

Course Code	Course Name	Credits
ILO 8022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to...

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	Overview of Indian Financial System: Characteristics, Components and Functions of Financial System. Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's	10

	Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	
05	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Entrepreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to...

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	Indian Environment for Entrepreneurship: key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Outcomes: Learner will be able to...

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	Introduction to HR • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	5
02	Organizational Behaviour (OB) • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	Organizational Structure & Design • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.	6

	• Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
04	Human resource Planning • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning • Training & Development: Identification of Training Needs, Training Methods	5
05	Emerging Trends in HR • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	6
06	HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries) Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to...

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to...

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	Introduction and Basic Research Concepts 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
03	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	08
05	Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04

06	Outcome of Research 6.1 Preparation of the report on conclusion reached 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to...

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	07

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press.

Course Code	Course Name	Credits
ILO 8028	Digital Business Management	03

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	Introduction to Digital Business- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	Overview of E-Commerce E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure	06
4	Managing E-Business- Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	E-Business Strategy- E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	Materializing e-business: From Idea to Realization- Business plan preparation Case Studies and presentations	08

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to...

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**

3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Lab Code	Lab Name	Credit
CSL801	Distributed Computing Lab	1

Prerequisite: Computer Networks and Operating Systems.

Lab Objectives:

1	To understand basic underlying concepts of forming distributed systems.
2	To learn the concept of clock Synchronization
3	To learn Election Algorithm.
4	To explore mutual exclusion algorithms and deadlock handling in the distributed system
5	To study resource allocation and management.
6	To understand the Distributed File System

Lab Outcomes: At the end of the course, the students will be able to

1	Develop test and debug using Message-Oriented Communication or RPC/RMI based client-server programs.
2	Implement techniques for clock synchronization.
3	Implement techniques for Election Algorithms.
4	Demonstrate mutual exclusion algorithms and deadlock handling.
5	Implement techniques of resource and process management.
6	Describe the concepts of distributed File Systems with some case studies.

Suggested List of Experiments

Sr. No.	Title of Experiment
1	Inter-process communication
2	Client/Server using RPC/RMI
3	Group Communication
4	Clock Synchronization algorithms
5	Election Algorithm.
6	Mutual Exclusion Algorithm
7	Deadlock Management in Distributed System
8	Load Balancing
9	Distributed shared Memory
10	Distributed File System (AFS/CODA)
11	Case Study: CORBA
12	Case Study: Android Stack

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of CSC801 and CSL801(Distributed Computing)
3	The final certification and acceptance of term work ensure satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral and Practical exam	
Based on the entire syllabus of CSC801: Distributed Computing and CSL801: Distributed Computing Lab	

Lab Code	Lab Name	Credit
CSDL8021	Deep Learning Lab	1

Prerequisite: Python Programming, Engineering Mathematics

Lab Objectives:

1	To implement basic neural network models for simulating logic gates.
2	To implement various training algorithms for feedforward neural networks.
3	To design deep learning models for supervised, unsupervised and sequence learning.

Lab Outcomes: At the end of the course, the students will be able to

1	Implement basic neural network models to learn logic functions.
2	Design and train feedforward neural networks using various learning algorithms.
3	Build and train deep learning models such as Autoencoders, CNNs, RNN, LSTM etc.

Suggested List of Experiments

1. Based on Module 1 (Any two) using Virtual Lab

1. Implement Mc-Culloch Pitts model for binary logic functions.
2. Implement Perceptron algorithm to simulate any logic gate.
3. Implement Multilayer Perceptron algorithm to simulate XOR gate.
4. To explore python libraries for deep learning e.g. Theano, TensorFlow etc.

2 Module 2 (Any Two)

5. Apply any of the following learning algorithms to learn the parameters of the supervised single layer feed forward neural network.
 - a. Stochastic Gradient Descent
 - b. Mini Batch Gradient Descent
 - c. Momentum GD
 - d. Nestorev GD
 - e. Adagrad GD
 - f. Adam Learning GD
6. Implement a backpropagation algorithm to train a DNN with at least 2 hidden layers.
7. Design and implement a fully connected deep neural network with at least 2 hidden layers for a classification application. Use appropriate Learning Algorithm, output function and loss function.

4. Module 3 (Any One)

8. Design the architecture and implement the autoencoder model for Image Compression.
9. Design the architecture and implement the autoencoder model for Image denoising.

5 Module 4 (Any One)

10. Design and implement a CNN model for digit recognition application.
11. Design and implement a CNN model for image classification.

6 Module 5 (Any One)

	12. Design and implement LSTM for Sentiment Analysis. 13. Design and implement GRU for classification on text data. 14. Design and implement RNN for classification of temporal data.

Term Work:	
1	Term work should consist of 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignment: 05-marks)
Practical and Oral exam	
	Based on the entire syllabus of CSDC8011: Deep Learning and CSDL8011: Deep Learning Lab

Lab Code	Lab Name	Credit
CSDL8022	Digital Forensics Lab	1

Prerequisite: Computer Network, Cryptography and System Security

Lab Objectives:

1	To demonstrate the procedures for identification, preservation, and acquisition of digital evidence.
2	To demonstrate techniques and tools used in digital forensics for operating systems and malware investigation.
3	To demonstrate tools formobile forensics and browser, email forensics
4	To explore scenario based crime forensics investigations.

Lab Outcomes: At the end of the course, the students will be able to

1	Explore various forensics tools and use them to acquire, duplicate and analyze data and recover deleted data.
2	Implement penetration testing using forensics tools.
3	Explore various forensics tools and use them to acquire and analyze live and static data.
4	Verification of source and content authentication of emails and browsers.
5	Demonstrate Timeline Report Analysis using forensics tools.
6	Discuss real time crime forensics investigations scenarios.

Suggested List of Experiments

Sr. No.	Title of Experiment
1	Analysis of forensic images using open source tools. • FTK Imager • Autopsy
2	Explore forensics tools in kali linux for acquiring, analyzing and duplicating data. • dd • dcfldd
3	Performing penetration testing using Metasploit - kali Linux.
4	Performing RAM Forensic to analyze memory images to find traces of an attack. • Capturing RAM Using the DumpIt Tool • Volatility tool
5	Network forensics using Network Miner.
6	Windows Recycle Bin Forensics
7	Data Carving using open source tools • Foremost • Scalpel • Jpegcarver
8	USB Device Forensics using • USBDeview • USB Detective
9	Web Browser Forensics using DB Browser for SQLite
10	Generate a Timeline Report Using Autopsy
11	Email Analysis
12	Case Study

Term Work:	
1	Term work should consist of 7 experiments covering all the modules and one case study.
2	Journal must include at least 2 assignments on content of theory and practical
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments & Case Study : 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSDC8012- Digital Forensics and CSDL8012- Digital Forensics Lab

Lab Code	Lab Name	Credit
CSL8023	Applied Data Science Lab	1

Prerequisite: Engineering Mathematics, Machine Learning, Programming fundamentals

Lab Objectives:

1	To explore various stages in the data science lifecycle.
2	To understand data preparation, exploration and visualization techniques.
3	To model and evaluate different supervised/unsupervised learning techniques.

Lab Outcomes: At the end of the course, the students will be able to

1	Apply various stages of the data science lifecycle for the selected case study.
2	Demonstrate data preparation, exploration and visualization techniques.
3	Implement and evaluate different supervised and unsupervised techniques.

Suggested List of Experiments

(Select a case study and perform the experiments 1 to 8.).

Star (*) marked experiments are compulsory.

Name of the Experiment

1.	Explore the descriptive and inferential statistics on the given dataset.
2.	Apply data cleaning techniques (e.g. Data Imputation).
3.	Explore data visualization techniques.
4.	Implement and explore performance evaluation metrics for Data Models (Supervised/Unsupervised Learning)
5.	Use SMOTE technique to generate synthetic data.(to solve the problem of class imbalance)
6.	Outlier detection using distance based/density based method.
7.	Implement time series forecasting.

Illustrate data science lifecycle for selected case study. (Prepare case study document for the selected case study)

Suggested Case Studies:

1. Customer Segmentation
2. Fraud Detection
3. House Price prediction
4. Product Recommendation
5. Stock price prediction
6. Weather prediction

Suggested Assignment List

Assignments can be given on self learning topics or data deployment tools.

Term Work:

1	Term work should consist of 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignment: 05-marks)

Practical and Oral exam

	Based on the entire syllabus of CSDC 8013: Applied Data Science and CSDL 8013: Applied Data Science Lab

Lab Code	Lab Name	Credit
CSDL8021	Optimization in Machine Learning Lab	1

Prerequisite: Algorithms and data structures

Lab Objectives:

1	To apply derivative based optimization techniques
2	To understand evolutionary optimization to a given machine learning problem.
3	To apply advanced evolutionary optimization
4	To design and analyze optimization problems for real world applications

Lab Outcomes: At the end of the course, the students will be able to

1	To implement derivative based optimization techniques
2	To implement evolutionary optimization
3	To implement advanced evolutionary optimization
4	To apply efficient optimization algorithm for real world applications

Suggested List of Experiments

Sr. No.	Title of Experiment
1	To implement Gradient Descent algorithm
2	To implement the Stochastic Gradient Descent algorithm
3	To implement Newton method
4	To apply Genetic Algorithm for real world problem
5	To compare and implement different selection mechanism using genetic algorithm
6	To implement various mutation and crossover mechanisms
7	To implement Particles Swarm optimization
8	To implement Ant colony optimization

Term Work:

1	Term work should consist of 6 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “ Optimization in Machine Learning ”
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments and assignments: 15-marks, Attendance Theory & Practical: 05-marks, Case study /Mini project: 05-marks)

Practical and Oral exam

	Based on the entire syllabus of CSDC8021: Optimization in Machine Learning and CSDL8021: Optimization in Machine Learning

Lab Code	Lab Name	Credit
CSDL8022	High Performance Computing Lab	1

Prerequisite: C Programming	
Lab Objectives: The objective of the course is to:	
1	Enable students to build the logic to parallelize the programming task.
2	Give insight about performance of parallel computing systems.
3	Provide hands-on experience on parallel programming platforms/frameworks
Lab Outcomes: After learning the course, the students will be able to:	
1	Perform Linux based commands on remote machine
2	Compare the performance of sequential algorithms with parallel algorithm in terms of execution time, speedup and throughput.
3	Implement parallel program using OpenMP library and analyze its performance
4	Implement parallel program using MPI platform and analyze its performance
5	Implement parallel program using OpenCL framework and analyze its performance
6	Implement parallel program using CUDA framework and analyze its performance

Suggested Experiments: Students are required to complete at least 8 experiments.	
Star (*) marked experiments are compulsory.	
Sr. No.	Name of the Experiment
1*	To analyse the Linux based computer systems using following commands: a. top , b.ps , c. kill, d. cat /proc/cpuinfo.e.vmstat Hardware/Software Requirement: Linux Operating System
2*	To setup SSH passwordless logins for two or more Linux based machines and execute commands on a remote machine. Hardware/Software Requirement: Linux Operating System, Multi-core computer systems
3*	Write a program in C to multiply two matrices of size 10000 x 10000 each and find it's execution-time using "time" command. Try to run this program on two or more machines having different configurations and compare execution-times obtained in each run. Comment on which factors affect the performance of the program. Hardware/Software Requirement: Linux Operating System, gcc compiler, Multi-core computer systems
4*	Write a "Hello World" program using OpenMP library also display number of threads created during execution. Hardware/Software Requirement: Linux Operating System, gcc compiler, Dual core with HT or Quad-core or higher computer system.
5*	Write a parallel program to calculate the value of PI/Area of Circle using OpenMP library. Hardware/Software Requirement: Linux Operating System, gcc compiler, Dual core

	with HT or Quad-core or higher computer system.
6*	Write a parallel program to multiply two matrices using openMP library and compare the execution time with its serial version. Also change the number of threads using omp_set_num_threads() function and analyse how thread count affects the execution time. Hardware/Software Requirement: Linux Operating System, gcc compiler, Dual core with HT or Quad-core or higher computer system.
7*	Install MPICH library and write a "Hello World" program for the same. Hardware/Software Requirement: Linux Operating System, MPICH, Multi-processor systems or MPI Cluster.
8*	Write a parallel program to multiply two matrices using MPI library and compare the execution-time with it's OpenMP and serial version. Hardware/Software Requirement: Linux Operating System, MPICH, gcc, Multi-processor systems, or MPI Cluster.
9*	Install MPICH on two and more machines and create a MPI cluster. Execute MPI programs on this cluster and check the performance. Hardware/Software Requirement: Linux Operating System, MPICH, Multi-processor systems or MPI Cluster.
10*	Implement a program to demonstrate balancing workload on MPI platform. Hardware/Software Requirement: Linux Operating System, MPICH, Multi-processor systems or MPI Cluster.
11	Implement a parallel program to demonstrate the cube of N number within a set range using MPI/OpenMP/OpenCL/CUDA. Hardware/Software Requirement: Linux Operating System, MPICH, Multi-processor systems or MPI Cluster. A CUDA-capable GPU, A supported version of Microsoft Windows, A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit
12	Implement DFT computation of vector using OpenCL/CUDA/ Parallel Matlab Hardware/Software Requirement: A CUDA-capable GPU, A supported version of Microsoft Windows, A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit
13	Implement Two Vector addition using OpenCL/CUDA/ Parallel Matlab Hardware/Software Requirement: A CUDA-capable GPU, A supported version of Microsoft Windows, A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit
14	Implement even-odd/Bucket /Radix /Shell sort using OpenCL/CUDA/ Parallel Matlab Hardware/Software Requirement: A CUDA-capable GPU, A supported version of Microsoft Windows, A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit

Term Work:	
1	Term work should consist of 8 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Practical and Oral Exam	
	Based on the entire syllabus of CSDC8022 : High Performance Computing and CSDL8022 High Performance Computing Lab

Lab Code	Lab Name	Credit
CSDL8023	Social Media Analytics Lab	1

Prerequisite: Types of Graphs, Data Mining, Data Analytics	
Lab Objectives:	
1	To understand the fundamental concepts of social media networks.
2	To learn various social media analytics tools and evaluation matrices.
3	To collect and store social media data.
4	To analyze and visualize social media data
5	To design and develop social media analytics models.
6	To design and build a social media analytics application.
Lab Outcomes: The students will be able to	
1	Understand characteristics and types of social media networks.
2	Use social media analytics tools for business
3	Collect, monitor , store and track social media data
4	Analyze and visualize social media data from multiple platforms
5	Design and develop content and structure based social media analytics models.
6.	Design and implement social media analytics applications for business.

Suggested Experiments:	
Sr. No.	Name of the Experiment
1	Study various - i) Social Media platforms (Facebook, twitter, YouTubeetc) ii) Social Media analytics tools (Facebook insights, google analytics net lyticetc) iii) Social Media Analytics techniques and engagement metrics (page level, post level, member level) iv) Applications of Social media analytics for business. e.g. Google Analytics https://marketingplatform.google.com/about/analytics/ https://netlytic.org/
2	Data Collection-Select the social media platforms of your choice (Twitter, Facebook, LinkedIn, YouTube, Web blogs etc) ,connect to and capture social media data for business (scraping, crawling, parsing).
3	Data Cleaning and Storage- Preprocess, filter and store social media data for business (Using Python, MongoDB, R, etc).
4	Exploratory Data Analysis and visualizationof Social Media Data for business.
5	Develop Content (text, emoticons, image, audio, video) based social media analytics model for business. (e.g. Content Based Analysis :Topic , Issue ,Trend, sentiment/opinion analysis, audio, video, image analytics)
6	Develop Structure based social media analytics model for any business. (e.g. Structure Based Models -community detection, influence analysis)
7	Develop a dashboard and reporting tool based on real time social media data.
8	Design the creative content for promotion of your business on social media

	platform.
9	Analyze competitor activities using social media data.
10	Develop social media text analytics models for improving existing product/ service by analyzing customer's reviews/comments.

Reference Books:

1	Python Social Media Analytics: Analyze and visualize data from Twitter, YouTube, GitHub, and more Kindle Edition by Siddhartha Chatterjee , Michal Krystianczuk
2	Learning Social Media Analytics with R,byRaghav Bali, Dipanjan Sarkar, Tushar Sharma.
3	Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013
4	Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013
5	Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

Term Work:

1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Practical and Oral Exam

Based on the entire syllabus of CSDC8023: **Social Media Analytics** and CSDL80223: **Social Media Analytics Lab**

Course Code	Course Name	Credit
CSP801	Major Project 2	06

Course Objectives::

The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification to successful completion of the project by implementing the solution.

Course Outcomes: Student will able to

1	Implement solutions for the selected problem by applying technical and professional skills.
2	Analyze impact of solutions in societal and environmental context for sustainable development.
3	Collaborate best practices along with effective use of modern tools.
4	Develop proficiency in oral and written communication with effective leadership and teamwork.
5	Nurture professional and ethical behavior.
6	Gain expertise that helps in building lifelong learning experience.

Guidelines:

1. Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.

2. Project Report Format:

At the end of semester, each group needs to prepare a project report as per the guidelines issued by the University of Mumbai. Report should be submitted in hardcopy. Also, each group should submit softcopy of the report along with project documentation, implementation code, required utilities, software and user Manuals.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey/ Existing system
- Limitation Existing system or research gap
- Problem Statement and Objective
- Proposed System
 - Analysis/Framework/ Algorithm
 - Design details
 - Methodology (your approach to solve the problem) Proposed System
- Experimental Set up

- Details of Database or details about input to systems or selected data
- Performance Evaluation Parameters (for Validation)
- Software and Hardware Set up
- Results and Discussion
- Conclusion and Future Work
- References
- Appendix – List of Publications or certificates

Desirable:

Students should be encouraged -

- to participate in various project competition.
- to write minimum one technical paper & publish in good journal.
- to participate in national / international conference.

3. Term Work:

Distribution of marks for term work shall be done based on following:

- a. Weekly Log Report
- b. Completeness of the project and Project Work Contribution
- c. Project Report (Black Book) (both side print)
- d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. Oral & Practical:

Oral & Practical examination (Final Project Evaluation) of Project 2 should be conducted by Internal and External examiners approved by University of Mumbai at the end of the semester.

Suggested quality evaluation parameters are as following:

- a. Relevance to the specialization / industrial trends
- b. Modern tools used
- c. Innovation
- d. Quality of work and completeness of the project
- e. Validation of results
- f. Impact and business value
- g. Quality of written and oral presentation
- h. Individual as well as team work

University of Mumbai



No. AAMS_UGS/ICC/2022-23/118

CIRCULAR :-

Attention of the Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology is invited to this office circular No.UG/42 of 2018-19 dated 25th June, 2018 relating to the revised syllabus for the T.E. & B.E. in Electronics & Telecommunication Engineering (Sem. - V to VIII) (CBCS).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Electronics and Telecommunication Engineering at its meeting held on 11th May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 vide item No. 6.30 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 vide item No. 6.30 (R) and that in accordance therewith, the revised syllabus of B.E.(Electronics and Telecommunication Engineering) (Sem. - VII & VIII) (CBCS) (REV-2019 'C' Scheme) has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

MUMBAI - 400 032

20th October, 2022

(Dr. Shailendra Deolankar)
I/c Registrar

To:

The Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology

A.C/6.30(R)/11/07/2022

No. AAMS_UGS/ICC/ 2022-23/ 118

20th October, 2022

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology,
- 2) The Chairman, Ad-hoc Board of Studies in Electronics and Telecommunication Engineering,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Director, Department of Information & Communication Technology,
- 6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Desktop/Circular of Engineering/Priya

Copy to :-

1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),
2. The Deputy Registrar, College Affiliations & Development Department (CAD),
3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),
4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),
5. The Deputy Registrar, Executive Authorities Section (EA),
6. The Deputy Registrar, PRO, Fort, (Publications Section),
7. The Deputy Registrar (Special Cell),
8. The Deputy Registrar, Fort/Vidyanagari Administration Department (FAD) (VAD), Record Section,
10. The Professor-cum- Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. P.A. to Hon'ble Vice-Chancellor,
2. P.A. to Pro-Vice-Chancellor,
3. P.A. to Registrar,
4. All Deans of all Faculties,
5. P.A. to Finance & Account Officer, (F. & A.O.),
6. P.A. to Director, Board of Examination & Evaluation,
7. P.A. to Director, Innovation, Incubation and Linkages,
8. P.A. to Director, Board of Lifelong Learning and Extension (BLLE),
9. The Director, Dept. Of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,
10. The Director of Board of Student Development,
11. The Director, Department of Students Welfare (DSD),
12. All Deputy Registrar, Examination House,
13. The Deputy Registrars, Finance & Accounts Section,
14. The Assistant Registrar, Administrative sub-campus Thane,
15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,
16. The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri,
17. The Assistant Registrar, Constituent Colleges Unit,
18. BUCTU,
19. The Receptionist,
20. The Telephone Operator,
21. The Secretary MUASA,

for information.

University of Mumbai



**Revised Syllabus for
B.E. (Electronics & Telecommunication Engineering)
(Sem. - VII to VIII)
(Choice Based Credit System)**

(With effect from the academic year 2022-23)

University of Mumbai



Syllabus for Approval

O: _____	Title of Course	B.E. (Electronics and Telecommunication Engineering)
O: _____	Eligibility	After Passing Third Year Engineering as per the Ordinance 0.6243
R: _____	Passing Marks	40%
No. of years/Semesters:		8 semesters
Level:		P.G. / U.G. / Diploma / Certificate
Pattern:		Yearly / Semester
Status:		New / Revised
To be implemented from Academic Year :		With effect from Academic Year : 2022-23

Chitay
Dr Faruk Kazi
Chairman
of Ad-hoc Board of
Studies in Electronics
and Telecommunication
Engineering

SK-oh
Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and
Technology

AHajumdar
Dr Anuradha Majumdar
Dean,
Faculty of Science and
Technology

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents **from NPTEL/ Swayam Platform**

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By BoS

Technological developments in the field of electronics and telecommunication engineering have revolutionized the way people see the world today. Hence, there is a need for continuously enriching the quality of education by a regular revision in the curriculum, which will help our students achieve better employability, start-ups, and other avenues of higher studies. The current revision in the Bachelor of Engineering program (REV- 2019 ‘C’ Scheme) aims at providing a strong foundation with required analytical concepts in the field of electronics and telecommunication engineering.

Some of the salient features of this revised curriculum are as below and they fall in line with the features in AICTE Model Curriculum.

1. The curriculum is designed in such a way that it encourages innovation and research as the total number of credits has been reduced from around 200 credits in an earlier curriculum to 171 credits in the current revision.
2. In the second and third-year curriculum, skill-based laboratories and mini-projects are introduced.
3. It will result in the students developing a problem-solving approach and will be able to meet the challenges of the future.
4. The University of Mumbai and BoS – Electronics and Telecommunication Engineering will ensure the revision of the curriculum on regular basis in the future as well and this update will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

The BoS would like to thank all the subject experts, industry representatives, alumni, and various other stakeholders for their sincere efforts and valuable time in the preparation of course contents, reviewing the contents, giving valuable suggestions, and critically analyzing the contents.

Board of Studies in Electronics and Telecommunication Engineering

Dr. Faruk Kazi: Chairman

Dr. V. N. Pawar: Member

Dr. Ravindra Duche: Member

Dr. Milind Shah: Member

Dr. R. K. Kulkarni: Member

Dr. Baban U. Rindhe: Member

Dr. Mrs. Nair: Member

Dr. Nalbarwar: Member

Dr. Sudhakar Mande: Member

Dr. S. D. Deshmukh: Member

Program Structure for Final Year Electronics & Telecommunication Engineering

Semester VII & VIII
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)
Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC701	Microwave Engineering	3	--	--	3	--	--	3
ECC702	Mobile Communication System	3	--	--	3	--	--	3
ECCDLO701X	Department Optional Course-3	3	--	--	3	--	--	3
ECCDLO702X	Department Optional Course-4	3	--	--	3	--	--	3
ILO701X	Institute Level Optional Course-1	3	--	--	3	--	--	3
ECL701	Microwave Engineering Laboratory	--	2	--	--	1	--	1
ECL702	Mobile Communication System Laboratory	--	2	--	--	1	--	1
ECP701	Major Project-I	--	6 [#]	--	--	3	--	3
Total		15	10	--	15	5	--	20

indicates work load of Learner (Not Faculty), for Major Project

Project Guide Load = ½ hour per week per project group

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Practical & Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC701	Microwave Engineering	20	20	20	80	3	--	--	100
ECC702	Mobile Communication System	20	20	20	80	3	--	--	100
ECCDLO 701X	Department Level Optional Course-3	20	20	20	80	3	--	--	100
ECCDLO 702X	Department Level Optional Course-4	20	20	20	80	3	--	--	100
ILO701X	Institute Level Optional Course-1	20	20	20	80	3	--	--	100
ECL701	Microwave Engineering Laboratory	--	--	--	--	--	25	25	50
ECL702	Mobile Communication System Laboratory	--	--	--	--	--	25	25	50
ECP701	Major Project-I	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	75	75	650

Department Level Optional Course-3

Course Code	Course Name
ECCDLO 7011	Efficient Architectures for DSP Algorithms
ECCDLO 7012	Deep Learning
ECCDLO 7013	Cloud Computing and Security
ECCDLO 7014	Big Data Analytics
ECCDLO 7015	Software Defined Radio

Department Level Optional Course-4

Course Code	Course Name
ECCDLO 7021	Robotics
ECCDLO 7022	5G Technology
ECCDLO 7023	Internet Communication Engineering
ECCDLO 7024	Advanced Digital Signal Processing
ECCDLO 7025	Quantum Computing

Institute Level Optional Course-1

Course Code	Course Name
ILO 7011	Product Lifecycle Management
ILO 7012	Reliability Engineering
ILO 7013	Management Information System
ILO 7014	Design of Experiments
ILO 7015	Operation Research
ILO 7016	Cyber Security and Laws
ILO 7017	Disaster Management and Mitigation Measures
ILO 7018	Energy Audit and Management
ILO 7019	Development Engineering

Program Structure for Final Year Electronics & Telecommunication Engineering

Semester VII & VIII
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)
Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC801	Optical Communication and Networks	3	--	--	3	--	--	3
ECCDLO801X	Department Level Optional Course-5	3	--	--	3	--	--	3
ECCDLO802X	Department Level Optional Course-6	3	--	--	3	--	--	3
ILO801X	Institute Level Optional Course-2	3	--	--	3	--	--	3
ECL801	Optical Communication and Networks Laboratory	--	2	--	--	1	--	1
ECP801	Major Project-II	--	12 [#]	--	--	6	--	6
Total		12	14	--	12	7	--	19

indicates work load of Learner (Not Faculty), for Major Project

Project Guide Load = 01 hour per week per project group

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Test 1	Test 2	Avg.					
ECC801	Optical Communication and Networks	20	20	20	80	3	--	--	100
ECCDLO801X	Department Level Optional Course-5	20	20	20	80	3	--	--	100
ECCDLO802X	Department Level Optional Course-6	20	20	20	80	3	--	--	100
ILO801X	Institute Level Optional Course-2	20	20	20	80	3	--	--	100
ECL801	Optical Communication and Networks Laboratory	--	--	--	--	--	25	25	50
ECP801	Major Project-II	--	--	--	--	--	50	100	150
Total		--	--	80	320	--	75	125	600

Department Level Optional Course-5

Course Code	Course Name
ECCDLO 8011	System On Chip Design
ECCDLO 8012	Natural Language Processing
ECCDLO 8013	Wireless Networks
ECCDLO 8014	Web Design
ECCDLO 8015	RF Design

Department Level Optional Course-6

Course Code	Course Name
ECCDLO 8021	Autonomous Vehicle
ECCDLO 8022	Satellite and Nano Satellite Communication
ECCDLO 8023	Network Management in Telecommunication
ECCDLO 8024	Microstrip Antenna
ECCDLO 8025	Augmented Reality and Virtual Reality

Institute Level Optional Course-1

Course Code	Course Name
ILO 8011	Project Management
ILO 8012	Finance Management
ILO 8013	Entrepreneurship Development and Management
ILO 8014	Human Resource Management
ILO 8015	Professional Ethics and CSR
ILO 8016	Research Methodology
ILO 8017	IPR and Patenting
ILO 8018	Digital Business Management
ILO 8019	Environmental Management

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC701	Microwave Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC701	Microwave Engineering	20	20	20	80	03	--	--	100

Course Pre-requisite: Knowledge of Electromagnetic Engineering

-

Course Objectives:

The course should enable the students to:

1. Perceive the concepts of waveguides and analyze the field components in different types of Waveguides.
2. Categorize different types of microwave components based on their applications.
3. Imbibe knowledge to use microwave oscillators & amplifiers in microwave communication and Compare their characteristics. IV.
4. Demonstrate the ability to measure different microwave parameters using microwave bench setup.

Course Outcomes:

1. Describe the types of waveguides, rectangular waveguides and field equations
2. Understand the coupling mechanisms in waveguides and analyze the waveguide multiport junctions
3. Explore the microwave linear tubes and analyze with microwave cross field tubes
4. Understand the microwave solid state devices and avalanche transit time devices
5. Demonstrate the microwave bench set up and conducting measurements of different parameters

Module No.	Unit No.	Topics	Hrs.
1.0		TRANSMISSION LINES	06
	1.1	Transmission line equations, open and short circuit transmission lines, variation of impedance over length of line, Smith chart, use of Smith chart in impedance matching	
	1.2	Planar transmission lines: microstrip line, strip line and coplanar lines	
2.0		WAVEGUIDES	07
	2.1	Introduction, microwave spectrum and bands, applications of microwaves, Types of waveguides, rectangular waveguides, field equations in rectangular waveguide, field components of TM and TE waves for rectangular waveguide, modes of TM and TE waves in rectangular waveguide, impossibility of TEM waves, cut off frequency of rectangular waveguide; Wave impedance in rectangular waveguide: Wave impedance for a TM and TE wave in rectangular waveguide, Dominant mode and degenerate modes, mode characteristics of phase velocity, group velocity, wavelength and impedance relations; Illustrative problems;	
	2.2	Cavity resonators: Types of cavity resonators; Rectangular cavity resonator: Dominant modes and resonant frequencies, illustrative problems.	
3.0		WAVEGUIDE COMPONENTS	06
	3.1	Coupling mechanisms: Probe, loop, coupling to a cavity resonator, waveguide discontinuities, waveguide irises, tuning screws and posts, matched loads; Waveguide attenuators; Waveguide phase shifters; waveguide	
	3.2	multiport junctions: E plane Tee, H plane Tee, Magic Tee, applications of Magic Tee, hybrid ring; Ferrites: Faraday rotation principle, gyrator, isolator, circulator	
4.0		MICROWAVE TUBES	10
	4.1	Microwave linear beam tubes (O type): Limitations of conventional tubes at microwave frequencies; Klystron: Velocity modulation process, bunching process, output power and beam loading; Multicavity Klystron amplifiers: Beam current density, output current and output power of two cavity Klystron; Reflex Klystron: Velocity modulation, power output and efficiency.	
	4.2	Helix Traveling Wave tube: Slow wave structures, amplification process, conventional current; Microwave cross field tubes (M type): Introduction, cross-field effects; Magnetrons: Different types, 8-cavity cylindrical travelling wave Magnetron, Hull cut-off and Hartree conditions, modes of resonance and PI-mode operation.	
5.0		MICROWAVE SEMICONDUCTOR DEVICES	06
	4.1	Microwave solid-state devices: Microwave tunnel diode; Pin diodes, varactor diodes, crystal detectors. Transferred electron devices: Gunn-effect diodes, RWH theory, modes of operations; Avalanche transit time devices: IMPATT diode, TRAPATT diode, BARITT diode,	
6.0		MICROWAVE MEASUREMENTS	04

	6.1	Description of microwave bench: Different blocks and their features, precautions; Microwave power measurement: Bolometers; Measurement of attenuation; Frequency standing wave measurements: measurement of low and high VSWR; Cavity Q; Impedance measurements.	
		Total	39

Text Books:

1. Samuel Y. Liao, —Microwave Devices and Circuits, Pearson, 3rd Edition, 2003.
2. Peter A. Rizzi, —Microwave Engineering Passive Circuits, PHI, 3rd Edition, 1999
3. M.L. Sisodia, G.S.Raghuvanshi, —Microwave Circuits and Passive Devices, Wiley Eastern Ltd., New Age International Publishers Ltd, 1st Edition, 1995.

Reference books

1. R.E. Collin —Foundations for Microwave Engineering, IEEE Press, John Wiley

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC702	Mobile Communication System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC702	Mobile Communication System	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC405 - Principles of Communication Engineering
ECC501 - Digital Communication
ECC602 - Computer Communication and Networks

Course Objectives:

1. To understand the cellular fundamentals and different types of radio propagation models.
2. To study evolution of 2G and 3G mobile technologies.
3. To illustrate the working principle of LTE.
4. To learn the concepts of emerging technologies for 4 G standards and beyond.

Course Outcomes:

After successful completion of the course student will be able to:

1. Explain the cellular fundamentals and estimate the coverage and capacity of cellular systems.
2. Classify different types of propagation models and analyse the link budget.
3. Compare and contrast GSM, GPRS, HSCSD, EDGE and IS-95 Technologies.
4. Apply the concepts of 3G technologies for UMTS and CDMA 2000.
5. Describe the features and working principle of 3GPP LTE.
6. Discuss the emerging technologies for upcoming mobile communication systems.

Module No.	Unit No.	Topics	Hrs.
1.0		Fundamentals of Mobile Communication	07
	1.1	Introduction to Wireless Communication: Mobile Radio Telephony, Examples of Wireless Communication Systems	01
	1.2	The Cellular Concept System Design Fundamentals: Frequency reuse, Channel assignment strategies, Interference and system capacity, Trunking and Grade of service, Improving Coverage and Capacity in Cellular System and related problems.	06
2.0		Mobile Radio Propagation	08
	2.1	Large scale fading: Free space propagation model, ground reflection (two-ray) model, practical Link budget design using path loss models. Self-learning: Basic propagation mechanisms, reflection, diffraction and scattering.	03
	2.2	Small scale fading: Small-scale multipath propagation, parameters of mobile multipath channels, types of small-scale fading, Rayleigh and Ricean distributions.	02
	2.3	Features of all conventional multiple access techniques: Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Space Spectrum Multiple Access (SSMA), Space Division Multiple Access (SDMA), Orthogonal Frequency Division Multiple Access (OFDMA), OFDM-PAPR	03
3.0		2G Technologies	08
	3.1	GSM: GSM Network Architecture, air interface specifications, GSM signaling protocol architecture, GSM channels, GSM services and features, GSM multifare structure, GSM speech coding, GSM Call procedures, Authentication and security in GSM, and handoff procedures in GSM.	04
	3.2	GSM evolution: GPRS, HSCSD and EDGE architecture, radio specifications	02
	3.3	IS-95: CDMA air interface, CDMA channels, power control in CDMA system, handoff, and RAKE receiver.	02
4.0		3G Technologies	05
	4.1	UMTS: Objectives, standardization and releases, network architecture, air interface specifications, channels, security procedure, W-CDMA air interface, attributes of W-CDMA system, W-CDMA channels.	03
	4.2	Cdma2000 cellular technologies: Forward and Reverse Channels, Handoff and Power Control.	02
5.0		3GPP LTE	06
	5.1	Introduction, system overview: Frequency bands and spectrum flexibility, network structure, protocol structure.	02
	5.2	Physical layer: Frames, slots, and symbols, modulation, coding, multiple-antenna techniques	02
	5.3	Logical and Physical Channels: Mapping of data onto (logical) sub-channels, Establishing a connection, Physical layer retransmissions and reliability, Power control, and handover.	02
6.0		Advanced techniques for 4G deployment and beyond	05
	6.1	Multi-antenna Techniques: Smart antennas, Multiple input Multiple output systems.	02
	6.2	Cognitive radio: Architecture, spectrum sensing. Software Defined Radio (SDR): Components and Applications.	02

	6.4	Introduction to 5G network and technologies used in 5G such as small cell concept, Massive MIMO, Beamforming, NOMA, and mm wave).	01
		Total	39

Textbooks:

1. T. L. Singal “wireless communications”, Mc Graw Hill Education.
2. Theodore S. Rappaport “wireless communications - principles and practice”, PEARSON, Second edition.
3. Andreas F. Molisch “wireless communications” WILEY INDIA PVT LTD, Second edition.

Reference Books:

1. Upena Dalal “Wireless and Mobile Communications”, Oxford university Press
2. Vijay K.Garg “Wireless Communications and Networking” ,Morgan–Kaufmann series in Networking-Elsevier.
3. J. H. Reed, Software-Defined Radio, Prentice-Hall, 2002
4. W. C. Y. Lee, Mobile Communication, Wiley
5. David Tse, Pramod Viswanath “Fundamentals of Wireless Communication” published by Cambridge University Press

E - Resources:

NPTEL courses:

1. <http://nptel.ac.in/courses/117104099/> - (Advanced 3G and 4G Wireless Mobile communications)
2. <https://nptel.ac.in/courses/117/102/117102062/> - (Wireless Communications)
3. Virtual lab: <http://vlab.co.in>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7011	Efficient Architectures for DSP Algorithms	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ECCDLO 7011	Efficient Architectures for DSP Algorithms	20	20	20	80	03	--	--	100

Course Prerequisite:

ECC303 Digital System Design
ECC404 Signals & Systems
ECC502 Discrete Time Signal Processing
ECC503 Digital VLSI Design
ECM601 Mini Project 2B- FPGA based Project

Course Objectives:

1. To describe the characteristics of computationally intensive algorithms
2. To identify the bottlenecks of intensive computations.
3. To learn various techniques to map DSP algorithms on hardware to improve performance.

Course Outcome:

After successful completion of the course students will be able to

CO1: Explain various typical DSP algorithms and their applications
CO2: Describe various methodologies/techniques to map DSP algorithms on Hardware
CO3: Analyze various hardware architectures available to implementation DSP algorithms
CO4: Evaluate and select efficient hardware architecture for implementation of given DSP algorithm.
CO5: Design/propose hardware architecture for effective implementation of given DSP algorithm.

Module No.	Unit No.	Topics	Hrs
1		Introduction to DSP Systems	06
	1.1	Typical DSP Algorithms, Graphical representation of DSP Algorithms	
	1.2	Signal flow graph (SFG), data flow graph (DFG) and dependence graph (DG), high level transformation, critical path	
2		Efficient Algorithm to Architecture Mapping	07
	2.1	Design of N-bit incrementer, decremter, complimenter ,	
	2.2	Techniques to enhance circuit performance, pipelining and parallel processing, circuit design for N bit natural numbers, optimized circuit design for different functions	
3		Efficient Adder Architecture	07
	3.1	Introduction to Adder design, Variable Block Adder circuit design, Delay optimized Carry Look Ahead Adder	
	3.2	Carry Select Sum Adder, Conditional Sum Adder, Ling's Adder	
	3.3	Prefix and Parallel prefix adders, Running Average Circuit	
4		Efficient Multiplier Design	07
	4.1	Array Multiplier ,Signed and Unsigned Multiplier ,Booths Multiplier , Bough-Wooley Multiplier	
	4.2	Architecture of Squaring Circuit, Reconfigurable Constant Multiplier Design	
5		DSP Architecture Design	06
	5.1	Floating point representation IEE754, floating point operations-2's compliment representation, adder, subtractor, multiplier	
	5.2	CORDIC Architecture, FFT Architecture, FIR filter	
6		Efficient Design of Machine Learning Hardware	06
	6.1	Artificial Intelligence and Machine Learning, Software and Co-design Optimizations, Pruning, Systolic array convolution	
	6.2	Hardware-Level Techniques, RTL design of sum of differences, Energy efficient hardware accelerator design methodology for Neural Networks	
		Total	39

Textbooks:

1. VLSI Digital Signal Processing Systems Design and Implementation – Khesab Parhi
2. COMPUTER ARITHMETIC Algorithms and Hardware Designs-Behrooz Parhami
3. **Machine Learning in VLSI-Ibrahim (Abe) M. Elfadel, Duane S. Boning, Xin Li Computer-Aided Design**

Reference Books:

1. Bill Franks, —Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, Wiley
2. Chuck Lam, —Hadoop in Action, Dreamtech Press

E-Resources:

1. <https://nptel.ac.in/courses/108105118>
2. <https://nptel.ac.in/courses/108106149>
3. <https://nptel.ac.in/courses/108105157>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7012	Deep Learning	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 7012	Deep Learning	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. ECC 604-Artificial Neural Networks and Fuzzy logic

Course Objectives:

At the end of the course, the students will be expected to:

1. Learn how to use TensorFlow for building and testing Deep Learning models
2. Compare various CNN architectures
3. Know the importance of Regularisation and Optimization techniques in Deep Learning networks
4. Learn Deep Learning models for working with sequential data
5. Understand motivation and functioning of the most common types of Autoencoders and apply such mechanisms to various learning problems.

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand the fundamentals of Deep Learning
2. Understand the concepts of TensorFlow, its main functions, operations and the execution pipeline
3. Improve deep learning models using Regularization and Optimization techniques
4. Compare the Convolution Neural Network architectures and use them as per the application
5. Design and implement Sequence Neural Network systems and solve real-world problems
6. Illustrate the working of Autoencoders and use them for real-life applications

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Deep learning	03
	1.1	History of Deep Learning- A Probabilistic Theory of Deep Learning	
	1.2	Introduction to Deep Feedforward Networks, Gradient Based Learning, Hidden Units	
	1.3	Architecture Design, Backpropagation Algorithm	
2.0		TensorFlow for Deep learning	06
	2.1	Introduction to TensorFlow using Python: Computational Graph, Key Highlights, Creating a Graph	
	2.2	Regression example, Gradient Descent, TensorBoard, Modularity, Sharing Variables, Keras	
	2.3	Preprocessing and Data Augmentation of Images and Datasets using TensorFlow	
3.0		Regularization and Optimization Techniques	06
	3.1	Regularization: Need of Regularization, L2 Regularization, L1 Regularization, Early Stopping and Dropout	
	3.2	Optimization: Challenges in NN Optimization, Gradient Descent Approaches, Parameter Initialization Approach, Adaptive Approaches - AdaGrad, RMSProp and Adam	
	3.2	Introduction to Batch Normalization	
4.0		Evolution of CNN in Deep Learning	08
	4.1	Review of CNN Architecture, Introduction of various CNN Architectures: LeNet, AlexNet, VGG, GoogleNet, ResNet and UNet	
	4.2	Comparison of CNN Architectures, Evaluation Parameters	
	4.3	Applications of CNN in Image Classification and Object Detection	
5.0		Sequence Modeling	08
	5.1	Recurrent and Recursive Nets: Recurrent Neural Networks, Bidirectional RNN, Encoder Decoder Architectures	
	5.2	Introduction to Long Short-Term Memory (LSTM) and Temporal Dependencies	
	5.3	Gated Recurrent Units (GRUs)	
	5.4	Applications of RNN in Real World- Image Captioning and Time Series Forecasting and Prediction	
6.0		Encoder Decoder Models	08
	6.1	Autoencoder: Encoder-Decoder Model, Training & Learning Manifold Space	
	6.2	Regularized Autoencoders: Sparse, De-noising and Contractive	
	6.3	Deep Autoencoder: Architecture and Working	
	6.4	Variational Autoencoders: Limitations of Autoencoders, Loss Function, Re-parameterization Trick, Latent Space Visualization	

	6.5	Applications of Autoencoders and Variational Autoencoders-Dimensionality Reduction , Image De-noising and Compression	
		Total	39
Self-learning Topics***: Deep learning applications in Object Localization, Video Classification, Content based Image Retrieval, Recommender System, End-to-End Speech Recognition and Machine Translation *** No questions to be asked in exams.			

Text Books:

1. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer International Publishing, 2018.
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.

Reference books

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer-Verlag, 2006.
2. Duda, Richard, Peter Hart, and David Stork, Pattern Classification, 2nd edition, Wiley-Interscience, 2000.
3. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.
4. Reza Zadeh, Bharath Ramsundar, TensorFlow for Deep Learning, 1st edition, O'Reilly Media Inc, 2018.
5. Zaccane, Giancarlo, Deep Learning with TensorFlow, 2nd edition, Packt Publishing, 2018.

NPTEL / Swayam Courses:

1. NPTEL course on Deep learning by Prof. Sudarshan Iyengar, IIT Ropar.
<https://nptel.ac.in/courses/106/106/106106184/>
2. NPTEL course on Deep learning by Prof. Prabir Kumar Biswas, IIT Kharagpur.
<https://nptel.ac.in/courses/106/105/106105215/>
3. NPTEL Course on Practical Machine Learning with TensorFlow by Prof. Balaraman Ravindran, IIT Chennai.
<https://nptel.ac.in/courses/106/106/106106213/>

Online Resources:

1. https://www.tensorflow.org/tutorials/images/data_augmentation
2. <https://towardsai.net/p/machine-learning/improving-artificial-neural-network-with-regularization-and-optimization>
3. <https://towardsdatascience.com/regularization-techniques-for-neural-networks-e55f295f2866>
4. <https://www.kaggle.com/sid321axn/regularization-techniques-in-deep-learning>
5. <https://medium.com/@minions.k/optimization-techniques-popularly-used-in-deep-learning-3c219ec8e0cc>
6. <https://www.jeremyjordan.me/variational-autoencoders/>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLOC 7013	Cloud Computing and Security	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLOC 7013	Cloud Computing and Security	20	20	20	80	03	--	--	100

Course Pre-requisite:

Computer Communication Network
Digital Encryption System

Course Objectives:

1. Understand the fundamentals of cloud computing .
2. Appreciate the importance of virtualization in cloud computing
3. Understand various cloud computing services and platforms
4. Understand application design concepts in cloud
5. Understand the security aspects of cloud computing
6. Understand the advances in cloud computing

Course Outcome:

After successful completion of the course student will be able to :-

1. Explain the fundamentals of cloud computing.
2. Interpret the significance of virtualization in the context of cloud computing
3. Describe cloud computing services working on AWS, Azure and Google cloud platforms
4. Explain application design aspects of cloud computing
5. Interpret security aspects to cloud computing.
6. Explain advances in cloud computing in terms of multimedia cloud, fog, edge computing and real applications of cloud.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Cloud	04
	1.1	Introduction to Cloud Computing, Cloud Characteristics, Cloud Computing Components, Comparing of Cloud Computing with Peer to Peer architecture, Client Server , Distributed, Grid, Cloud Deployment model (Cloud types- Public, Private, Community, Hybrid), Service Models-(IaaS,PaaS,SaaS,)	
2.0		Virtualization	07
	2.1	Introduction & benefit of Virtualization – Implementation Levels of Virtualization- VMM Design Requirements and Providers – Virtualization at OS level – Middleware support for Virtualization– Virtualization structure/tools and mechanisms: Hypervisor and Xen Architecture, Binary Translation with full Virtualization, Para Virtualization with Compiler Support - Virtualization of CPU, Memory and I/O Devices, Hardware support for Virtualization in intel x86 processor – CPU Virtualization – MemoryVirtualization and I/O Virtualization – Virtualization in Multicore processors	
3.0		Cloud Computing Services	10
	3.1	Compute Services - Amazon Elastic Compute Cloud, Google Compute Engine, Windows Azure Virtual Machines Storage Services - Amazon Simple Storage Service, Google Cloud Storage, Windows Azure Storage Database Services - Amazon Relational Data Store, Amazon DynamoDB, Google Cloud SQL, Google Cloud Datastore, Windows Azure SQL Database, Windows Azure Table Service Application Services - Application Runtimes & Frameworks, Queuing Services, Email Services, Notification Services, Media Services	
	3.2	Content Delivery Services - Amazon CloudFront, Windows Azure Content Delivery Network Analytics Services - Amazon Elastic MapReduce, Google MapReduce Service, Google BigQuery, Windows Azure HDInsight Deployment & Management Services - Amazon Elastic Beanstalk, Amazon CloudFormation Identity & Access Management Services - Amazon Identity & Access Management, Windows Azure Active Directory Open Source Private Cloud Software - CloudStack, Eucalyptus, OpenStack	
4.0		Cloud Application Design	06
	4.1	Design Considerations for Cloud Applications - Scalability, Reliability & Availability, Security, Maintenance & Upgradation, Performance	
	4.2	Cloud Application Design Methodologies - Service Oriented Architecture, Cloud Component Model, IaaS, PaaS and SaaS services for cloud applications, Model View Controller, RESTful Web Services, Data Storage Approaches - Relational (SQL) Approach, Non-Relational (No-SQL) Approach	
5.0		Cloud Security	06
	5.1	Security for Virtualization Platform – Host security for SaaS, PaaS and IaaS – Data Security – Data Security Concerns – Data Confidentiality and Encryption – Data Availability –Data Integrity – Cloud Storage Gateways – Cloud Firewall	
	5.2	AAA Administration for Clouds -AAA model – SSO for Clouds – Authentication management and Authorization management in clouds – Accounting for Clouds Resource utilization.	

6.0		Cloud Computing Applications	06
	6.1	Cloud Computing for Health care, Education, Transportation, Manufacturing Industry, Energy System, Mobile Computing	
	6.2	Multimedia Cloud - Introduction, Streaming Protocols - RTMP Streaming, HTTP Live Streaming, HTTP Dynamic Streaming	
	6.3	Case Studies - Live Video Streaming App , Video Transcoding App, Edge Computing, FOG Computing	
		Total	39

Text books :

1. Cloud Computing - A Hands-on Approach - Arshdeep Bahga and Vijay K. Madiseti
2. Mastering Cloud Computing: Foundations and Applications Programming Paperback – by Rajkumar Buyya , Christian Vecchiola , S.Thamarai Selvi , Publisher: Morgan Kaufmann
3. Amazon Web Services For Dummies (For Dummies Series) Paperback by Bernard Golden, Publisher: John Wiley & Sons
4. “The Cloud Computing Book: The Future of Computing Explained” , Douglas E. Comer
5. Cloud Computing for Dummies, Judith Hurwitz Daniel Kirsch

Reference books

1. Cloud Computing Black Book : Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah by Kogent Learning Solutions , Publisher : Dreamtech Press
2. Cloud Computing Concepts Technology and Architecture - Erl second hand book online from UsedBooksFactory
3. Practical Cloud Security by Chris Dotson, Publisher(s): O'Reilly Media, Inc. ISBN: 9781492037514
4. AWS Whitepapers & Guides <https://aws.amazon.com/whitepapers/>
5. Azure whitepapers <https://azure.microsoft.com/en-in/resources/whitepapers/>
6. Google Cloud whitepapers <https://cloud.google.com/whitepapers>

MOOC

1. NPTEL Swayam Course on Cloud computing By Prof. Soumya Kanti Ghosh
<https://nptel.ac.in/courses/106/105/106105167/>
2. Cloud Computing and Distributed Systems By Prof. Rajiv Misra
https://onlinecourses.nptel.ac.in/noc22_cs18/preview
3. Google Cloud Computing Foundation Course
<https://nptel.ac.in/courses/106/105/106105223>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-1). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7014	Big Data Analytics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 7014	Big Data Analytics	20	20	20	80	03	--	--	100

Course Prerequisite:

Basic knowledge of Database Management System

Course Objectives:

1. To Provide an Overview of an exciting growing field of Big Data Analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql, Map Reduce.
3. To teach the fundamental techniques in achieving big data analytics with scalability and streaming capability

Course Outcome:

After successful completion of the course student will be able to

1. Understand the key issues in big data management and its associated applications in intelligent business and scientific computing.
2. Acquire fundamental enabling techniques and scalable algorithms like Hadoop, MapReduce and NoSQL in big data analytics.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc
5. Develop applications for Big Data analysis using Hadoop and NoSQL etc.

Module No.	Unit No.	Topics	Hrs
1		Introduction to Big Data Analytics	03
	1.1	Introduction to Big Data, Big Data characteristics, Types of Big Data, Traditional vs. Big Data a business approach	
	1.2	Technologies Available for Big Data, Infrastructure for Big Data, Big Data Challenges, Case Study of Big Data Solutions.	
2		Hadoop	05
	2.1	Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem-Apache HBase, Hive, HCatalog, Pig, Mahout, Oozie, Zookeeper, Sqoop, Physical Architecture, Hadoop limitations.	
3		NoSQL	06
	3.1	Introduction to NoSQL, NoSQL business drivers, NoSQL database case studies.	
	3.2	NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns	
	3.3	Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems Managing MongoDB database with CRUD operations.	
4		MapReduce	06
	4.1	MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization.	
	4.2	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures	
	4.3	Algorithms Using MapReduce: MapReduce WordCount Program, Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations by MapReduce, Matrix Operations, Matrix Multiplication by MapReduce.	
5		Techniques in Big Data Analytics	13
	5.1	Finding Similar Item: Nearest Neighbor Search, Similarity of Documents, Distance Measures: Euclidean, Jaccard , Cosine , Edit and Hamming Distance with its Examples	
	5.2	Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis Filtering streams: The Blooms filter.	
	5.3	Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a	

		search engine, Efficient computation of Page Rank: Page Rank Implementation Using MapReduce	
	5.4	Frequent Itemset Mining: Market-Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu	
6		Big Data Analytics Applications	06
	6.1	Recommendation Systems: Introduction, A Model for Recommendation Systems: Collaborative-Filtering System, Content based system and its Examples.	
	6.2	Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Network. Clustering of Social Graphs: Applying Standard Clustering Techniques, Counting triangles using MapReduce.	
		Total	39

Textbooks:

1. Radha Shankarmani and M Vijayalakshmi —Big Data Analytics, Wiley
2. Alex Holmes —Hadoop in Practice, Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly —Making Sense of NoSQL – A guide for managers and the rest of us, Manning Press.

Reference Books:

1. Bill Franks, —Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, Wiley
2. Chuck Lam, —Hadoop in Action, Dreamtech Press

E-Resources:

1. <https://www.analyticsvidhya.com/blog/2014/05/hadoop-simplified>
2. <https://www.analyticsvidhya.com/blog/2014/05/introduction-mapreduce/>
3. <https://www.pdfdrive.com/big-data-analytics-a-hands-on-approach-e158549112.html>
4. <https://www.pdfdrive.com/data-science-and-big-data-analytics-e58447171.html>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLOC 7015	Software Defined Radio	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLOC 7015	Software Defined Radio	20	20	20	80	03	--	--	100

Prerequisites:

- Computer Communication and Networks
- Mobile Communication Systems

Course Objectives: The objective of this course is

1. To introduce fundamental knowledge of Software Defined Radio (SDR) and Cognitive Radio (CR) technology in next generation networks.
2. To introduce the hardware and software requirements and design aspects of CR
3. To introduce the architecture, spectrum sensing, spectrum awareness and allocation in CR networks.
4. To introduce the various standards available in CR technology and GNU platform for experimentation.

Course Outcomes: After learning the course the students will be able to demonstrate the ability

1. To Learn the hardware and software architecture and various design principles of SDR
2. To understand challenges of receiver design and select suitable hardware and software for SDR.
3. To understand the functions, components and challenges of CR technology for better spectrum exploitation.
4. To analyze various spectrum sensing techniques in CR environment.
5. To understand and apply the techniques of dynamic spectrum allocation and scheduling in CR based networks.
6. To understand various standards of CR Technology and its role in next generation networks and GNU platform.

Module No	Unit No.	Topic	No. of Hrs
1		Software Defined Radio	5
	1.1	Basic components of Software Defined Radios, Software defined radio hardware architectures	
	1.2	Distortion parameters - Sources and metrics of distortion in a transceiver, Nonlinear distortion and nonlinearity specifications, Power amplifiers: Nonlinear Distortion in Transmitted Signals	
2		SDR Architecture and Components	8
	2.1	Power amplifier Line-up for linearity & power requirement calculations, Linearization Techniques for nonlinear distortion in SDR, Pre distortion Techniques for nonlinear distortion in SDR	
	2.2	Digital Pre distortion Techniques for Linear/Nonlinear Distortion	
	2.3	SDR Software architecture, Software Tunable Analog Radio Components	
	2.4	Antenna Systems, Reconfigurable Digital Radio Technologies, Basic Digital Radio Components	
3		Cognitive Radio	6
	3.1	Cognitive radio features and capabilities: Cognitive radio architecture Functions of cognitive radio Dynamic spectrum access, Components of cognitive radio Interference temperature ,Spectrum sensing Spectrum analysis and spectrum decision	
	3.2	Research challenges in Cognitive Radio: Issues in spectrum sensing, Spectrum management issues Spectrum mobility issues , Network layer and transport layer issues, Cross-layer design for cognitive radio networks, Artificial intelligence approach for designing cognitive radio, Location-aware cognitive radio	
4		Spectrum Sensing for Cognitive Radio	6
	4.1	Challenges, Matched Filtering, Waveform-Based Sensing, Cyclostationarity - Based Sensing, Energy Detector-Based Sensing, Radio Identification, Cooperative Sensing, External Sensing, Statistical Approaches and Prediction.	
	4.2	Sensing Frequency, Hardware Requirements and Approaches, Multi-dimensional Spectrum Awareness	
5		Dynamic spectrum access and management in Cognitive Radio	8
	5.1	Spectrum access models : Exclusive-use model , Shared-use model Spectrum commons model	
	5.2	Dynamic spectrum access architecture: Infrastructure-based versus infra structure less cognitive radio network Centralized versus distributed dynamic spectrum access Inter- and intra-RAN dynamic spectrum allocation	
	5.3	Medium access control for dynamic spectrum access :	

		Optimal decision on spectrum sensing and spectrum access Multichannel and multiuser MAC Spectrum allocation and scheduling, Spectrum trading Performance analysis of cognitive MAC protocols	
6		Advanced topics in Cognitive Radio	6
	6.1	Cognitive radio architectures for NeXt Generation (XG) networks	
	6.2	Cognitive radio standardization : IEEE SCC 41, IEEE 802.22 for wireless regional area networks (WRANs)	
	6.3	GNU Radio for cognitive radio experimentation	
		Total	39

Recommended Books:

1. Huseyin Arslan, “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems”, Springer, 2007
2. Ekram Hossain, Dusit Niyato, Zhu Han, “Dynamic Spectrum Access and Management in Cognitive Radio Networks”, Cambridge University Press, 2009
3. Bruce Fette, “Cognitive radio technology”, Elsevier, 2nd edition, 2009.
- 4 Alexandar M Wylingskey, Maziar Nikovee, Y Thomas Hou, “Cognitive Radio Communications and Networks Principles and Practice”, Elsevier, 2010

REFERENCES:

1. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive radio networks”, John Wiley & Sons Ltd., 2009.
2. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, “Optimizing Wireless Communication Systems” Springer, 2009.
3. Linda Doyle, “Essentials of Cognitive Radio”, Cambridge University Press, 2009.

E-Resources:

1. NPTEL: <https://nptel.ac.in/courses/108/107/108107107/>
2. GNU Radio: <https://www.gnuradio.org/>
<https://wiki.gnuradio.org/index.php/Tutorials>
<http://www.gcndevelopment.com/gnuradio/downloads.html>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7021	Robotics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 7021	Robotics	20	20	20	80	03	--	--	100

Course Prerequisite: - Engineering Mathematics III and IV

Course Objectives:

1. To introduce the functional elements of Robotics
2. To impart knowledge on the direct and inverse kinematics
3. To introduce the manipulator differential motion and control
4. To educate on various path planning techniques
5. To introduce the dynamics and control of manipulators
6. To study about the localization, planning and navigation

Course Outcomes:

After successful completion of the course students will be able to

- Explain basic concept of robotics.
- Describe the differential motion, add statics in robotics
- Describe the various path planning techniques.
- Describe the dynamics and control in robotics industries.
- Write program to use a robot for a typical application
- Use Robots in different applications

Module No.	Unit No.	Topics	Hrs.
1.	BASIC CONCEPTS		3
	1.1	Brief History	
	1.2	Types of Robot–Technology-Robot classifications and specifications	
	1.3	Design and Control issues	
	1.4	Various manipulators	
	1.5	Sensors , work cell	
	1.6	Programming languages	
2.	DIRECT AND INVERSE KINEMATICS		8
	2.1	Mathematical representation of Robots - Position and orientation	
	2.2	Homogeneous transformation Various joints, Degrees of freedom	
	2.3	Representation using the Denavit Hattenberg parameters	
	2.4	Direct kinematics-Inverse kinematics	
	2.5	Solvability – Solution methods-Closed form solution	
	2.6	SCARA robots-	
3.	PATH PLANNING		8
	3.1	Joint space technique	
	3.2	Use of p-degree polynomial, Cubic polynomial, Cartesian space technique	
	3.3	Parametric descriptions	
	3.4	Straight line and circular paths	
	3.5	Position and orientation planning	
4.	DYNAMICS AND CONTROL		7
	4.1	Lagrangian mechanics	
	4.2	2DOF Manipulator	
	4.3	Lagrange Euler formulation	
	4.4	Dynamic model	
	4.5	Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator	
5.	SERVICE ROBOTICS		7
	5.1	Need for service robots	
	5.2	LOCALIZATION: Challenges of Localization- Map Representation- Probabilistic Map based Localization Monte carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems- Route based localization	
	5.3	PLANNING AND NAVIGATION: Path planning overview, Cell decomposition path planning Potential field path planning-Obstacle avoidance	
6.	APPLICATIONS		6
	6.1	Ariel robots	
	6.2	Collision avoidance	
	6.3	Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications	
	6.4	Humanoids	
Total			39

Text Books:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.

3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
4. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, USA, 2004

Reference Books:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998
5. Riadh Siaer, „The future of Humanoid Robots- Research and applications, Intech Publications, 2012.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7022	5G Technology	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 7022	5G Technology	20	20	20	80	03	--	--	100

Course pre-requisite:

Digital Communication
Mobile Communication Systems

Course Objectives:

1. Learn the basics of 5G and beyond wireless communication
2. Study 5G network architecture and Heterogeneous Network and Small cells
3. Provide understanding of the key technologies and enablers of 5G and beyond communication systems.
4. Learn 5G technology like massive MIMO, mmWave etc.

Course Outcome:

After successful completion of the course student will be able to:

1. Distinguish between the major cellular communication standards (1G/2G/3G/4G/5G systems) and architecture of wireless communications networks.
2. Apply the 5G techniques e.g., massive MIMO, mmWave etc. for the design of communication systems.
3. Analyse various modulation and multiplexing techniques e.g., OFDM, NOMA etc.
4. Describe applications of cognitive radio in 5G Wireless Communications.

Module No.	Unit No.	Topics	Hrs.
1		Introduction	04
	1.1	Introduction to 5G Technology, Features, Requirements, Applications, 5G Services, Introduction to 5Gi	
	1.2	Digital modulations (OFDM, 5G Technology Modulation Techniques) and performance metrics, 5G Internet, Internet of Things and Context-Awareness, Software Defined Networking, Network Function Virtualisation (NFV)	
2		5G Architecture	08
	2.1	5G Network Architecture, Cloud RAN(C-RAN), Definitions of Heterogeneous Networks, Radio Resource and Interference Management for Heterogeneous Networks, Traffic offloading scenarios for heterogeneous networks, mobility management and handover	
	2.2	Small cell deployments: different types, Deployment scenarios, performance and analysis, Energy efficient mechanism with BS sleep mode in green small cell networks, Game theory and learning techniques for self-organization in small cell networks, 3GPP RAN standards for small cell	
3		Mm Wave	08
	3.1	mmWave: Millimeter bands, radio-wave propagation Physical layer design and algorithms, mmWave MIMO challenges, channel modelling, channel estimation and Beam-forming. Types of transceivers, Merits and Demerits, Applications	
	3.2	Physical or Radio layer Technologies - Massive MIMO (Sub 6Ghz) -mm wave MIMO (above 6 GHz)	
4		NOMA	05
		Non orthogonal Multiple Access (NOMA), Different Types: power domain NOMA and code domain NOMA, Difference between Orthogonal multiple access and NOMA, Filter Bank multi carrier -Full duplex Radio Techniques, Precoding	
5		Cognitive Radio for 5G Wireless Networks	08
	5.1	Introduction, Overview of Cognitive Radio Technology in 5G Wireless, Spectrum Optimisation using Cognitive Radio, Cognitive Radio and Carrier Aggregation, Energy-Efficient Cognitive Radio Technology	
	5.2	Cognitive Radios to Mitigate Interference in Macro/femto Heterogeneous Networks, Cognitive Radio enabled Operations, Interference Coordination: Orthogonality in the Time/Frequency domain, Intra-tier Interference mitigation, Compressive sensing	
6		Trends in 5G	06
		5G NR, Carrier Aggregation in 5G, Open RAN, Use cases of 5G:eMBB, URLLC and mMTC, Advance applications: Robotic surgery, driverless car and Industrial IoT (IIoT), Tactile Internet, 5G-IoT applications, AR/VR in 5G	
		Total	39

Text books:

1. Principles of Modern Wireless communication systems by Aditya k Jagannathan
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

Reference books

1. R. Vannithamby and S. Talwar, Towards 5G: Applications, Requirements and Candidate Technologies., John Willey & Sons, West Sussex, 2017.
2. Manish, M., Devendra, G., Pattanayak, P., Ha, N., 5G and Beyond Wireless Systems PHY Layer Perspective, Series in Wireless Technology Springer, 2021
3. Alagan Anpalagan, Mehdi Bennis, Rath Vannithamby, Design and deployment of small cell networks, Cambridge university press, 2015
4. Rose Qingyang Hu, Yi Qian, Heterogeneous Cellular Networks, John Wiley & Sons, Ltd., Publication, 2013
5. T. S. Rappaport, R. W. Heath Jr., R. C. Daniels, and J. M. Murdock, Millimeter Wave Wireless Communication., Pearson Education, 2015.
6. M. Vaezi, Z. Ding, and H. V. Poor, Multiple Access techniques for 5G Wireless Networks and Beyond., Springer Nature, Switzerland, 2019

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7023	Internet Communication Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test 1	Test 2	Avg.					
ECCDLO 7023	Internet Communication Engineering	20	20	20	80	03	--	--	100

Course Pre-requisite:

- Analog communication
- Digital Communication
- Computer Communication and Networks

Course Objectives:

1. To focus on Internet protocol, standards, services and administration.
2. To discuss the Internet security protocol and security services
3. To discuss multimedia communication standards and compression techniques
4. To add insights on software defined network & network automation
5. To introduce Internet of Things

Course Outcomes:

After successful completion of the course student will be able to:

1. Compare the protocols at each layer of TCP/IP protocol suite.
2. Explain the internet security aspects of protocols at various layers of TCP/IP protocol suite.
3. Apply the various compression algorithms for audio, image & video coding.
4. Categorize and design simple networked multimedia systems.
5. Compare integrated & differentiated services for quality of service.
6. Explain a software defined Network.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Internet	03
	1.1	What is the Internet, Evolution of the Internet, service description, Network protocol?	
	1.2	Overview of TCP/IP, layer functions	
2.0		Application Layer in the Internet	06
	2.1	Application Layer- Host configuration, DHCP, Domain Name System (DNS), Multicast DNS	
	2.2	Remote Login, TELNET and SSH, HTTPS, electronic mail	
3.0		Internet Security	05
	3.1	Network layer security (AH, ESP, IPsec)	
	3.2	Transport layer security (SSL), Application layer security (secure E mail-PGP, S/MIME)	
	3.3	VPN Firewall, Intrusion Detection System.	
4.0		Multimedia Communications	10
	4.1	Information Representation- text, images, audio and video, Text and image compression, Audio and video compression, video	
	4.2	compression standards: H.261, H.263, P1.323, MPEG 1, MPEG 2, Other coding formats for text, speech, image and video	
	4.3	multimedia transport across IP networks and relevant protocols such as RSVP, RTP, RTCP, DVMRP, Signalling Protocols: Real-Time Streaming Protocol (RTSP).	
	4.4	VoIP, IPTV	
5.0		Quality of Services (QoS)	07
	5.1	Integrated services (intserv): Architecture and Service Model, Resource Reservation Protocol (RSVP), Packet Scheduling Disciplines in the Internet	
	5.2	Differentiated Services (diffserv): Framework and Concept, Assured and Expedited Services, Packet Classification, Routers Internals and Packet Dropping Techniques	
6.0		Network Industry Trends & Automation	08
	6.1	Introduction to software defined networking, OPENFLOW	
	6.2	Why network automation? Simplified Architectures, Deterministic outcomes, Business Agility, Types of network automation, Device Provisioning, Data collection, Migrations, Configuration Management, Compliance, Reporting, Troubleshooting, Evolving from the management plane from SNMP to device APIs--- Impact of open networking, Network Automation in the SDN era.	
	6.3	Introduction to Internet of Things (IoT): Definition and characteristics of IoT, Physical design of IoT: Things in IoT, IoT Protocols.	
		Total	39

Text Books:

1. B. Forouzan, —*TCP/IP Protocol Suite*l, 4th Edition, McGraw-Hill Publication
2. K. R. Rao, Zaron S. Bojkovic, Dragorad A. Milocanovic, Multimedia Communication Systems, Prentice Hall India, 2002. ISBN: 81-203-2145-6.
3. Network Programmability & Automation---Jason Edelman, Scott S. Lowe & Matt Oswalt, OREILLY.

References:

1. Steve Heath, Multimedia and Communication Technology, Second Edition, Focal Press, 2003.
2. ISBN: 81-8147-145-8. Ted Wallingford, —*Switching to VoIP*l, Oreilly Publication
3. Fred Halsall, —Multimedia Communicationsl, Pearson education, 2001
4. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, —Multimedia Communication Systemsl, Pearson education, 2004
5. Raif steinmetz, Klara Nahrstedt, —Multimedia: Computing, Communications and Applicationsl, Pearson education, 2002
6. Tay Vaughan, —Multimedia: Making it Workl, 6th edition, Tata McGraw Hill, 2004
7. Pallapa Venkataram, —Multimedia information systemsl, Pearson education (InPress),2005.
8. Multimedia Communication Techniques and Standards
9. Arshdeep Bagha, Vijay Madiseti “Internet of Things”, universities Press.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7024	Advanced Digital Signal Processing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 7024	Advanced Digital Signal Processing	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC502 Discrete-Time Signal Processing

Course Objectives:

1. To develop a thorough understanding of power spectrum estimation and different models for the same.
2. To apply optimum linear filters, linear prediction, and adaptive filtering techniques for signal processing applications.
3. To process multi-rate data.
4. To develop multi-resolution analysis using wavelets.

Course Outcomes:

After successful completion of the course student will be able to:

1. Illustrate parametric and non-parametric techniques of power spectrum estimation.
2. Explain optimum linear filters and their different forms.
3. Perform linear estimation and prediction of discrete time signals.
4. Implement various types of adaptive filters for the given applications.
5. Design interpolator, decimator and sampling rate convertors for multi-rate signal processing.
6. Apply concepts of wavelets and filter banks for signal processing applications.

Module No.	Unit No.	Topics	Hrs.
1.0		Power Spectrum Estimation	09
	1.1	Principle of Power Spectrum Estimation	
	1.2	Non Parametric Method of Power Spectrum Estimation: Modified Periodogram, Bartlett's Method, Welch's Method, Blackman-Tukey Method	
	1.3	Parametric Methods for Power Spectrum Estimation: Relationships between the Autocorrelation and the Model Parameters, AR, MA & ARMA Models	
	1.4	Introduction to Least-Squares Method for the AR Model Parameters and Yule-Walker Method for the AR Model Parameters	
2.0		Optimum Linear Filters	03
	2.1	Wiener Filters	
	2.2	FIR Wiener Filter (Wiener-Hopf filter)	
	2.3	IIR Wiener filter (Non-Causal and Causal IIR Wiener Filter)	
	2.4	Orthogonality Principle in Linear Mean-Square Estimation	
3.0		Linear Prediction	05
	3.1	Forward and Backward Linear Prediction	
	3.2	Solution of Normal Equation (Levinson-Durbin and Schur Algorithm)	
	3.3	AR Lattice and ARMA Lattice Ladder Filters	
	3.4	MMSE Estimation	
	3.5	Introduction to Kalman Filter, Matched Filter	
4.0		Adaptive Filters	07
	4.1	Adaptive Algorithms: LMS Algorithm, NLMS Algorithm, RLS Algorithm, Lattice Ladder Algorithm	
	4.2	Applications of Adaptive Filters: System Identification, Adaptive Channel Equalization, Echo Cancellation, Adaptive Noise Cancellation	
		Self-Study: Suppression of Narrowband Interference in Wideband Signals, Adaptive Array	
5.0		Multi-rate Signal Processing	08
	5.1	Introduction to Multi-rate Signal Processing	
	5.2	Interpolation and Decimation, Sampling Rate Conversion by Non-integer Factor	
	5.3	Multistage Interpolation and Decimation	
	5.4	Polyphase Decomposition	
	5.5	Filter Banks: Quadrature Mirror Filter Banks	
		Self-Study: Subband Coding	
6.0		Introduction to Wavelets	07
	6.1	Limitations of Fourier Transform and Short Time Fourier Transform, Introduction to Time-Frequency Tiling	
	6.2	Multi-resolution analysis using Discrete Time Wavelet Transform: Haar MRA, Analysis of two band dyadic filter banks, Frequency response of the Haar Filter Bank	
	6.3	Introduction to Daubechies Wavelets	
	6.4	Application of Wavelet theory to Signal Denoising (Soft and Hard Thresholding)	
		Self-Study: Signal Compression, Image Compression	
Total			39
Note: No questions will be asked in the end semester exam from self-study topics. However, students are encouraged to explore these topics for better understanding of the subject.			

Textbooks:

1. John G. Proakis, Dimitris K. Manolakis, "Digital Signal Processing Principles, Algorithms, and Applications", Prentice-Hall, 4th Edition, 2012.
2. Simon Haykin, "Adaptive Filter Theory", Pearson Education, Fourth Edition, 2002
3. Martin Vetterli, Jelena Kovacevic, "Wavelets and Subband Coding", Prentice-Hall, 1995.
4. Burrus, C. Sidney, Ramesh A. Gopinath, and Haitao Guo, "Introduction to wavelets and wavelet transforms", Prentice Hall Inc. 1997"

Reference Books:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing: A Practical Approach", Pearson Education, 2008.
2. E. Chandrasekhar, V. P. Dimri, V. M. Gadre (Eds.), "Wavelets and Fractals in Earth System Sciences", CRC Press, 2013.
3. Tarun Kumar Rawat, "Digital Signal Processing", Oxford University Press, 2014.
4. K. Deergha Rao, M.N.S. Swamy, "Digital Signal Processing: Theory and Practice", Springer, 2018.
5. K. P. Soman, K.I. Ramchandran and N. G. Reshmi, "Insight into Wavelets: From Theory to Practice", Third Edition PHI, 2010.
6. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice-Hall, 1993.
7. Sanjit K. Mitra, "Digital Signal Processing: A Computer-Based Approach", McGraw Hill, 2011.

NPTEL / Swayam Course:

1. "Estimation of Signals and Systems" by Prof. S. Mukhopadhyay, IIT Kharagpur.
<https://nptel.ac.in/courses/108/105/108105059/>
2. "Adv. Digital Signal Processing - Multirate and wavelets" by Prof. V. M. Gadre, IIT Bombay.
<https://nptel.ac.in/courses/117/101/117101001/>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-1). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7025	Quantum Computing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 7025	Quantum Computing	20	20	20	80	03	--	--	100

Course pre-requisite:

ECC303- Digital System Design
ECC301-Engineering Mathematics-III
ECCDLO5014- Data Structures and Algorithm
ECL404-Skill Lab: Python Programming

Course Objectives:

1. To understand basics of quantum computing
2. To understand mathematics required for quantum computing.
3. To understand building blocks of quantum computing.
4. To understand quantum algorithms.
5. To understand quantum hardware principles.
6. To understand tools for quantum computing.

Course Outcome:

After successful completion of the course student will be able to :-

1. Explain basic concepts of quantum computing
2. Explain mathematical fundamentals required for quantum computing.
3. Explain building blocks of quantum computing through architecture and programming models.
4. Explain quantum algorithms.
5. Explain quantum hardware building principles.
6. Explain usage of tools for quantum computing.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Quantum Computing	07
	1.1	Motivation for studying Quantum Computing	
	1.2	Origin of Quantum Computing	
	1.3	Quantum Computer vs. Classical Computer	
	1.4	Introduction to Quantum mechanics	
	1.5	Overview of major concepts in Quantum Computing Qubits and multi-qubits states Bloch Sphere representation Quantum Superposition Quantum Entanglement	
	1.6	Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.)	
2.0		Mathematical Foundations for Quantum Computing	05
	2.1	Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.	
3.0		Building Blocks for Quantum Program	08
	3.1	Architecture of a Quantum Computing platform	
	3.2	Details of q-bit system of information representation: Block Sphere Multi-qubits States Quantum superposition of qubits (valid and invalid superposition) Quantum Entanglement Useful states from quantum algorithmic perceptive e.g. Bell State Operation on qubits: Measuring and transforming using gates. Quantum Logic gates and Circuit No Cloning Theorem and Teleportation	
	3.3	Programming model for a Quantum Computing Program Steps performed on classical computer Steps performed on Quantum Computer Moving data between bits and qubits.	
4.0		Quantum Algorithms and Error correction	06
	4.1	Quantum Algorithms Shor's Algorithm Grover's Algorithm Deutsch's Algorithm Deutsch -Jozsa Algorithm	
	4.2	Quantum error correction using repetition codes 3 qubit codes Shor's 9 qubit error correction Code	
5.0		Quantum Hardware	10
	5.1	Ion Trap Qubits The DiVincenzo Criteria Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating Rotor	
	5.2	Quantum Mechanics of a Free Rotor: A Poor Person's Atomic Model: Rotor Dynamics and the Hadamard Gate, Two-Qubit Gates The Cirac-Zoller Mechanism: Quantum Theory of Simple Harmonic Motion, A Phonon-Qubit Pair Hamiltonian, Light-Induced Rotor-Phonon Interactions,	

		Trapped Ion Qubits, Mølmer-Sørensen Coupling ..	
	5.3	Cavity Quantum Electrodynamics (cQED): Eigenstates of the Jaynes-Cummings Hamiltonian Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms, Superconducting Qubits	
	5.4	Quantum computing with spins: Quantum inverter realized with two exchange coupled spins in quantum dots, A 2-qubit spintronic universal quantum gate.	
6.0		OSS Toolkits for implementing Quantum program	03
	6.1	IBM quantum experience	
	6.2	Microsoft Q Rigetti PyQuil (QPU/QVM)	
		Total	39

Text books:

1. Michael A. Nielsen, “Quantum Computation and Quantum Information”, Cambridge University Press.
2. David McMahon, “Quantum Computing Explained”, Wiley ,2008
3. Qiskit textbook <https://qiskit.org/textbook-beta/>
4. Vladimir Silva, Practical Quantum Computing for Developers,2018
5. Bernard Zygelman, A First Introduction to Quantum Computing and Information,2018
6. Supriyo Bandopadhyay and Marc Cahy, “Introduction to Spintronics”, CRC Press, 2008.

Reference books

1. The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-Technologies, Lars Jaeger
2. La Guardia, Giuliano Gladioli “Quantum Error correction codes”Springer,2021

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7011	Product Life Cycle Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ILO 7011	Product Life Cycle Management	20	20	20	80	03	--	--	100

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to...

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM	10
02	Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering	09

	and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
03	Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05
Total		39

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004, ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7012	Reliability Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ILO 7012	Reliability Engineering	20	20	20	80	03	--	--	100

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to...

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts	05

	standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	
06	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05
Total		39

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillon, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Connor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7013	Management Information System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ILO 7013	Management Information System	20	20	20	80	03	--	--	100

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to...

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6

06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8
Total		39

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7014	Design of Experiments	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ILO 7014	Design of Experiments	20	20	20	80	03	--	--	100

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to...

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	Introduction 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	Fitting Regression Models 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	Two-Level Factorial Designs 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design,	07

	3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	
04	Two-Level Fractional Factorial Designs 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	Response Surface Methods and Designs 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
06	Taguchi Approach 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04
Total		39

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7015	Operations Research	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ILO 7015	Operations Research	20	20	20	80	03	--	--	100

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to...

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	Introduction to Operations Research: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m	14

	Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02	Queuing models: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	Simulation: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05
Total		39

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Lieberman, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7016	Cyber Security and Laws	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ILO 7016	Cyber Security and Laws	20	20	20	80	03	--	--	100

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to...

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	Introduction to Cybercrime: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	Cyber offenses & Cybercrime: How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	Tools and Methods Used in Cyberline Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	The Concept of Cyberspace E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	Indian IT Act.	6

	Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	
06	Information Security Standard compliances SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6
Total		39

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneth J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional : <https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7017	Disaster Management and Mitigation Measures	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ILO 7017	Disaster Management and Mitigation Measures	20	20	20	80	03	--	--	100

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to...

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration	06

	3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06
Total		39

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.

3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7018	Energy Audit and Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ILO 7018	Energy Audit and Management	20	20	20	80	03	--	--	100

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to...

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	Energy Scenario: Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	Energy Audit Principles: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08

03	Energy Management and Energy Conservation in Electrical System: Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	Energy Management and Energy Conservation in Thermal Systems: Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03
Total		39

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7019	Development Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ILO 7019	Development Engineering	20	20	20	80	--	--	--	100

Course objectives:

- To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
- To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
- An exploration of human values, which go into making a ‘good’ human being, a ‘good’ professional, a ‘good’ society and a ‘good life’ in the context of work life and the personal life of modern Indian professionals
- To understand the Nature and Type of Human Values relevant to Planning Institutions

Course outcomes:

After successful completion of the course student will be able to

- Apply knowledge for Rural Development.
- Apply knowledge for Management Issues.
- Apply knowledge for Initiatives and Strategies
- Develop acumen for higher education and research.
- Master the art of working in group of different nature.
- Develop confidence to take up rural project activities independently

Module No.	Unit No.	Topics	Hrs.
1.0			08
	1.1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	
2.0			04
	2.1	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	
3.0			06
	3.1	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
4.0			04
	4.1	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	
5.0			10

	5.1	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	
6.0			04
	6.1	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	
		Total	36

References :

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL701	Microwave Engineering Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECL701	Microwave Engineering Laboratory	--	--	--	--	--	25	25	50

Course Objectives:

1. To become familiar working with rectangular waveguides and doing microwave bench set up
2. To determine the characteristics of various microwave components
3. To be able to measure wave parameters like impedance, frequency, wavelength using microwave bench and VSWR/power meter
4. To study characteristics and behavior of various microwave semiconductor devices.

Course outcomes: On completion of this lab course the students will be able to:

1. Able to handle microwave equipments
2. Able to understand microwave measurements and test the characteristics of microwave components
3. Able to understand Wave guide and transmission line measurements
4. Demonstrate working of microwave semiconductor devices
5. Demonstrate the microwave bench set up and conducting measurements of different parameters

	Suggested List of Experiments
1	Measurement of microwave frequency using direct and indirect method
2	Measurement of guide wavelength
3	Measurement of VSWR of unknown load
4	Measurement of impedance of unknown load.
5	Study of field patterns of various modes inside a rectangular waveguide cavity using Virtual lab
6	Study of field patterns of various modes inside a rectangular waveguide using Virtual lab
7	Find the change in characteristics impedance and reflection coefficients of the transmission line by changing the dielectric properties of materials Embedded between two conductors. using Virtual lab
8	Determination of VI characteristics of Gunn diode using microwave test bench.
9	Measurement of attenuation
10	Measurement of microwave power
11	Characterization of E plane TEE, H plane TEE and Magic TEE
12	Measurement of reflection coefficient using transmission line bench

Term Work:

At least 8 experiments covering the entire syllabus must be given “**Batch Wise**”. The experiments can be conducted with the help of appropriate hardware setup/simulation tool (preferably open source)/breadboard and components. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments graded from time to time. The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all the 8 experiments for examination.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL702	Mobile Communication System Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL702	Mobile Communication System Laboratory	--	--	--	--	25	25	50

Course objectives:

1. To understand the inter-dependencies of design parameters of cellular system.
2. To examine orthogonality condition for CDMA systems.
3. To Classify different types of propagation models and analyze the link budget
4. To understand the working principles of OFDM, MIMO, and Cognitive radio.

Course outcomes:

After the successful completion of the course student will be able to

1. Demonstrate the effect of cellular system design parameters on system capacity and quality of service.
2. Compare and contrast trunking radio systems.
3. Examine the effect of small-scale fading parameters on the performance of radio channel characteristics.
4. Analyze link budget for various propagation path-loss models.
5. Summarize the attributes of OFDM, MIMO, and Cognitive radio.
6. Evaluate the performance of different MIMO systems.

Suggested list of experiments: (Course teacher can design their own experiments based on the prescribed syllabus)

Suggested Experiment List

- To observe the effect of velocity and direction of arrival of a vehicle on Doppler frequency.
- To observe the effect of Cluster size (N) on C/I ratio and comment on the voice quality.
- To observe the effect of incidence angle on reflection coefficient.
- To observe the effect of different propagation models on coverage distance.
- To analyze the effect of delay on blocking probability of a call for Erlang B and Erlang C systems.

- To observe the effect of C/I ratio in a sectorised cell site and perform worst case analysis for different values of N and degree of sectorisation
 - A) Worst case C/I in a 3-sector cellular system for N = 7
 - B) Worst case C/I in a 3-sector cellular system for N = 4
 - C) Worst case C/I in a 6-sector cellular system for N = 7
 - D) Worst case C/I in a 6-sector cellular system for N = 4
- To generate Pseudo noise code used in a CDMA system.
- To generate Walsh Codes using Hadamard Matrix.
- To plot Knife edge diffraction gain as a function of Fresnel diffraction parameter.
- To analyze the effect of multipath diversity (RAKE receiver) on Bit Error Rate in CDMA system.
- To plot channel capacity versus SNR for different MIMO systems.
- Simulation of OFDMA system.
- GSM Network simulation.
- CDMA Network simulation.
- Simulation of spectrum sensing using energy detection method in cognitive radio.
- Demonstration of OFDM / MIMO /Cognitive radio.

Term Work, Practical and Oral:

At least 8 experiments covering the entire syllabus must be given “**Batch Wise**”. The experiments can be conducted with the help of simulation tool (preferably open source) and breadboard and components. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments graded from time to time. The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all the 8 experiments for examination.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECP701	Major Project-1	--	06	--	--	3	--	3

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECP701	Major Project-1	--	--	--	--	25	25	--	50

Objective: The Project work enables the students to develop the required skills and knowledge gained during the programme by applying them for the analysis of a specific problem or issue, via a substantial piece of work which is carried out over an extended period. It also enables the students to demonstrate the proficiency in the design of a research project, application of appropriate research methods, collection and analysis of data and presentation of results.

Guidelines:

1. Project Topic:

- To proceed with the project work it is very important to select a right topic. Project can be undertaken on any domain of electronics and telecommunication programme. Research and development projects on problems of practical and theoretical interest should be encouraged.
- Project work must be carried out by the group of at least two students and maximum four and must be original.
- Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements.
- The project work can be undertaken in a research institute or organization/company/any business establishment.
- Student must consult internal guide along with external guide (if any) in selection of topic.
- Head of department and senior staff in the department will take decision regarding selection of projects.
- Student has to submit weekly progress report to the internal guide and whereas internal guide has to keep track on the progress of the project and also has to maintain attendance report. This progress report can be used for awarding the term work marks.

- In case of industry projects, visit by internal guide will be preferred.

2. **Project Report Format:**

At the end of semester a project report should preferably contain at least following details:-

- Abstract
- Introduction
- Literature Survey
 - a) Survey Existing system
 - b) Limitation of the Existing system or research gap
 - c) Problem Statement and Objective
 - d) Scope
- Proposed System
 - a) Analysis/Framework/ Algorithm
 - b) Details of Hardware & Software
 - c) Design details
 - d) Methodology (your approach to solve the problem)
- Implementation Plan for next semester
- Conclusion
- References

3. **Term Work:**

Distribution of marks for term work shall be as follows:

- a) Weekly Attendance on Project Day
- b) Contribution in the Project work
- c) Project Report (Spiral Bound)
- d) Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. **Oral & Practical :**

Oral & Practical examination of Project-I should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project- I.

University of Mumbai



No. AAMS(UG)/ 130 of 2022-23

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/167 of 2017-18 dated 8th August, 2017, relating to the revised syllabus as per (CBCS) for Bachelor of Engineering (Mechanical Engineering) (Sem. III & VIII) be revised for S.E. (Sem. III & IV) from Academic Year 2017-18, Third Year (Sem. V & VI) from Academic Year 2018-19 and Bachelor of Engineering (Sem. VII & VIII) from Academic Year 2019-20.

You are hereby informed that the recommendations made by the Board of Studies in **Mechanical Engineering** at its meeting held on 31st May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 vide item No. 6.45 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 vide item No. 6.45 (R) and that in accordance therewith, the revised syllabus of **B.E. (Mechanical Engineering) (Sem.- VII & VIII) (CBCS)**, has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

MUMBAI - 400 032

20th October, 2022

(Dr. Shailendra Deolankar)
I/c Registrar

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.45 (R)/11/07/2022

No. AAMS(UG)/ 130 -A of 2022-23

20th October, 2022

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology,
- 2) The Chairman, Board of Studies in Mechanical Engineering,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Director, Department of Information & Communication Technology,
- 6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Copy to :-

- 1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
- 2. The Deputy Registrar, College Affiliations & Development Department (CAD),**
- 3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
- 4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
- 5. The Deputy Registrar, Executive Authorities Section (EA),**
- 6. The Deputy Registrar, PRO, Fort, (Publication Section),**
- 7. The Deputy Registrar, (Special Cell),**
- 8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
- 9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

- 1. P.A to Hon'ble Vice-Chancellor,**
- 2. P.A Pro-Vice-Chancellor,**
- 3. P.A to Registrar,**
- 4. All Deans of all Faculties,**
- 5. P.A to Finance & Account Officers, (F.& A.O),**
- 6. P.A to Director, Board of Examinations and Evaluation,**
- 7. P.A to Director, Innovation, Incubation and Linkages,**
- 8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
- 9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
- 10. The Director of Board of Student Development,**
- 11. The Director, Department of Students Welfare (DSD),**
- 12. All Deputy Registrar, Examination House,**
- 13. The Deputy Registrars, Finance & Accounts Section,**
- 14. The Assistant Registrar, Administrative sub-Campus Thane,**
- 15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
- 16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
- 17. The Assistant Registrar, Constituent Colleges Unit,**
- 18. BUCTU,**
- 19. The Receptionist,**
- 20. The Telephone Operator,**
- 21. The Secretary MUASA**

for information.

University of Mumbai



**Revised Syllabus for
B.E. (Mechanical Engineering)
Semester – (VII & VIII)
(Choice Based Credit System)**

(With effect from the academic year 2022-23)

University of Mumbai



O: _____	Title of Course	B.E. (Mechanical Engineering)
O: _____	Eligibility	After Passing Third Year Engineering as per the Ordinance 0.6243
R: _____	Passing Marks	40%
No. of years/Semesters:		8 semesters
Level:		P.G. / U.G. / Diploma / Certificate
Pattern:		Yearly / Semester
Status:		New / Revised 2019 'C' Scheme
To be implemented from Academic Year :		With effect from Academic Year : 2022-23

Signature:

Dr. Vivek Sunnapwar
Chairman
of Board of Studies in
Mechanical Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and
Technology

Signature:

Dr Anuradha Majumdar
Dean,
Faculty of Science and
Technology

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' Scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the Institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

When the entire world is discussing about 'Industry 4.0', we are at the crossroads. There are so many expectations from the graduating engineers, who shall be the major contributors to ecosystem for development of the Nation. Engineering education in India, in general, is being revamped so as to impart the theoretical knowledge along with industrial exposure. It is our attempt, when we are introducing a new curriculum; to bridge the industry-academia gap. To enable this, we have introduced components such as skill-based laboratories and project-based learning. We trust that this will allow the learner to apply knowledge gained in previous and current semesters to solve problems for gaining better understanding. What once were pure mechanical systems have now been transformed into multidisciplinary systems of mechatronics, electronics and computer science. Interdisciplinary knowledge is gaining importance as we are moving towards automated world as technology advances. Keeping this in mind the curriculum has been designed in a way so that learner shall be acquainted with many Interdisciplinary subjects.

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. The Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by several faculty members and Industry experts. The Program Educational Objectives proposed for the undergraduate program in Mechanical Engineering are listed below:

1. To prepare the stake holder to exhibit leadership qualities with demonstrable attributes in lifelong learning to contribute to the societal needs.
2. To make ready the stake holder to pursue higher education for professional development
3. To help the stake holder to acquire the analytical and technical skills, knowledge, analytical ability attitude and behavior through the program
4. To prepare the stakeholders with a sound foundation in the mathematical, scientific and engineering fundamentals
5. To motivate the learner in the art of self-learning and to use modern tools for solving real life problems and also inculcate a professional and ethical attitude and good leadership qualities
6. To prepare the stake holder to able to Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

We trust this revised version of syllabus come up to the expectations of all stakeholders. We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar	: Chairman
Dr. S. M. Khot	: Member
Dr. V. M. Phalle	: Member
Dr. Siddappa Bhusnoor	: Member
Dr. S.S. Pawar	: Member
Dr. Sanjay U. Bokade	: Member
Dr. Dhanraj Tambuskar	: Member
Dr. V. B. Tungikar	: Member
Dr. K.P. Karunakaran	: Member
Dr. S. S. Thipse	: Member
Dr. Milind Deshmukh	: Member

Program Structure for Final Year Engineering
Semester VII & VIII
UNIVERSITY OF MUMBAI
(With Effect from 2021-2022)
Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
MEC701	Design of Mechanical System	4	--	4	--	4
MEC702	Logistics and Supply Chain Management	3	--	3		3
MEDLO703X	Department Level Optional Course – 3	3	--	3	--	3
MEDLO704X	Department Level Optional Course – 4	3	--	3	--	3
ILO701X	Institute Level Optional Course – I*	3	--	3	--	3
MEL701	Design of Mechanical System	--	2	--	1	1
MEL702	Maintenance Engineering	--	2	--	1	1
MEL703	Industrial Skills	--	2	--	1	1
MEP701	Major Project I	--	6 [#]	--	3	3
Total		16	12	16	6	22

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/ Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
MEC701	Design of Mechanical System	20	20	20	80	3	--	--	100
MEC702	Logistics and Supply Chain Management	20	20	20	80	3	--	--	100
MEDLO703X	Department Level Optional Course – 3	20	20	20	80	3	--	--	100
MEDLO704X	Department Level Optional Course – 4	20	20	20	80	3	--	--	100
ILO701X	Institute Level Optional Course – I*	20	20	20	80	3	--	--	100
MEL701	Design of Mechanical System	--	--	--	--	--	25	25	50
MEL702	Maintenance Engineering	--	--	--	--	--	25	25	50
MEL703	Industrial Skills	--	--	--	--	--	25	25	50
MEP701	Major Project I	--	--	--	--	--	50	--	50
Total		--	--	100	400	--	125	75	700

indicates work load of Learner (Not Faculty), for Major Project

* Common with all branches

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract.	Total
MEC801	Operations Planning and Control	3	--	3	--	3
MEDLO805X	Department Level Optional Course – 5	3	--	3	--	3
MEDLO806X	Department Level Optional Course – 6	3	--	3	--	3
ILO802X	Institute Level Optional Course – 2*	3	--	3	--	3
MEL801	Product Design and Development	--	2	--	1	1
MEL802	Laboratory based on IoT	--	2	--	1	1
MEP801	Major Project II	--	12 [#]	--	6	6
Total		12	16	12	8	20

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac./Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (Hrs)			
		Test1	Test2	Avg					
MEC801	Operations Planning and Control	20	20	20	80	3	--	--	100
MEDLO805X	Department Level Optional Course – 5	20	20	20	80	3	--	--	100
MEDLO806X	Department Level Optional Course – 6	20	20	20	80	3	--	--	100
ILO802X	Institute Level Optional Course – 2*	20	20	20	80	3	--	--	100
MEL801	Product Design and Development	--	--	--	--	--	25	25	50
MEL802	Laboratory based on IoT	--	--	--	--	--	25	25	50
MEP801	Major Project II	--	--	--	--	--	100	50	150
Total		--	--	80	320	--	150	100	650

indicates work load of Learner (Not Faculty), for Major Project

* Common with all branches

Students group and load of faculty per week.

Major Project 1 and 2:

Students can form groups with minimum 2 (Two) members and not more than 4 (Four) members

Faculty Load: In Semester VII – ½ hour per week per project group

In Semester VIII – 1 hour per week per project group

Department Optional Courses

Course Code	Sem. VII: Department Optional Course- 3	Course Code	Sem. VII: Department Optional Course - 4
MEDLO7031	Automotive Power Systems	MEDLO7041	Machinery Diagnostics
MEDLO7032	Renewable Energy Systems	MEDLO7042	Vibration Controls
MEDLO7033	Vehicle Systems	MEDLO7043	Advanced Vibration

Course Code	Sem. VIII: Department Optional Course- 5	Course Code	Sem. VIII: Department Optional Course - 6
MEDLO8051	Composite Materials	MEDLO8061	Product Design and Development
MEDLO8052	Smart Materials	MEDLO8062	Design for X
MEDLO8053	Micro Electro Mechanical Systems	MEDLO8063	Total Quality Management

Institute Optional Courses

Course Code	Institute Optional Course-I #	Course Code	Institute Elective Course-II #
ILO7011	Product Lifecycle Management	ILO8021	Project Management
ILO7012	Reliability Engineering	ILO8022	Finance Management
ILO7013	Management Information System	ILO8023	Entrepreneurship Development and Management
ILO7014	Design of Experiments	ILO8024	Human Resource Management
ILO7015	Operation Research	ILO8025	Professional Ethics and CSR
ILO7016	Cyber Security and Laws	ILO8026	Research Methodology
ILO7017	Disaster Management and Mitigation Measures	ILO8027	IPR and Patenting
ILO7018	Energy Audit and Management	ILO8028	Digital Business Management
ILO7019	Development Engineering	ILO8029	Environmental Management

Common with all branches

Course Code	Course Name	Credits
MEC701	Design of Mechanical System	04

Objectives:

1. To familiarize with the concept of system and methodology of system design
2. To study system design of various systems such as Gear box, snatch block, belt conveyors, I. C. engine system and pumps

Outcomes: Learner will be able to...

1. Apply the concept of system design.
2. Select appropriate gears for power transmission on the basis of given load and speed
3. Design material handling systems such as hoisting mechanism of EOT crane,
4. Design belt conveyor systems
5. Design engine components such as cylinder, piston, connecting rod and crankshaft
6. Design pumps for the given applications

Module	Contents	Hours
1.	Methodology & Morphology of design, Optimum design, system concepts in design.	04
2.	Design of Transmission Gear Box: Single stage and Two stage Gear box with fixed ratio consisting of Design of spur, helical, bevel and worm and wormwheel gear pairs, Gear box housing layout and housing design.	12
3.	Design of Hoisting Mechanism: Design of Snatch Block Assembly including Rope Selection, Sheave, Hook, Bearing for hook, cross piece, Axle for sheave and shackle plate, Design of rope drum, selection motor with transmission system.	10
4.	Design of Belt Conveyors : Power requirement, selection of belt, design of tension take up unit, idler pulley	04
5.	Engine Design (Petrol and Diesel): Design of cylinder, Piston with pin and rings, connecting rod & crank shaft with bearings	10
6.	Design of Pump: 5.1 Design of main components of gear pump. 1 Motor selection 2 Gear design 3 Shaft design and bearing selection 4 Casing and bolt design 5 Sizing of design of suction and delivery pipe 5.2 Design of main components of Centrifugal Pump: 1 Motor selection	08

	2 Suction and Delivery pipe	
	3 Design of Impeller, Impeller shaft	
	4 Design of Volute Casing	

Sr. no.

Text/Reference Books: -

- 1 “Machine Design Exercises”, S.N.Trikha - New Delhi Khanna Publisher 1978.
- 2 “Mechanical Engineering Design”, Shigley J E and Mischke C R, 11th Edition 2019, McGraw Hill, ISBN: 9788184956207.
- 3 “Mechanical design analysis”, MF Spotts, 3rd Edition, Prentice Hall Inc.
- 4 “Design of Machine Elements”, Bhandari VB, 5th Edition 2020, TMH, ISBN: 9789390177479
- 5 “Machine Design”, Black PH and O Eugene Adams, 3rd Edition, McGraw Hill
ISBN 10: 0070055246
- 6 “Design Data”, P.S.G. College of Technology, Coimbatore. ISBN: 978-8192735504
- 7 “Engineering Design”, Dieter G E, McGraw Hill Inc, ISBN: 9781260113297
- 8 “Mechanical System Design”, SP Patil, 2nd Edition., JAICO Publishing House ISBN: 978-8179923153
- 9 “Material Handling Equipment”, Rudenko, 2nd Edition, M.I.R. publishers, Moscow
- 10 “Machine Design-An Integrated Approach”, Robert L. Norton, 6th Edition, Pearson Education, ISBN: 9780135184233
- 11 “Material Handling Equipments”, N. Rudenko, Peace Publication
- 12 “Material Handling Equipments”, Alexandrov, 5th Edition, Mir Publication ISBN: 9780714717456
- 13 “Machine Design”, Reshetov, Mir Publication 1978.
- 14 “Machine Design”, R.C.Patel, Pandya, Sikh, Vol -I & II, 12th Edition, C. Jamnadas & Co.
- 15 “Design of Machine Elements”, 4th Edition, V. M. Faires, ISBN: 978-0023359507
- 16 “Pumps: Theory, Design and Applications”, G K Sahu, New Age International 2000 ISBN: 9788122412246

- 17 “Gear Design Handbook”, GitinMaitra, 2nd Edition, ISBN: 978-0074602379
- 18 “Design Data Book- Design of engine parts”,Khandare S.S & Kale A.V, 2nd Edition, ISBN: 978-9352654260

Links for online NPTEL/SWAYAM courses:

1. https://onlinecourses.nptel.ac.in/noc22_me62 - Gear And Gear Unit Design: Theory and Practice, IIT Kharagpur
2. <https://nptel.ac.in/courses/112/106/112106137/> - Machine Design-II, IIT Madras

Course Code	Course Name	Credits
MEC702	Logistics and Supply Chain Management	03

Objectives:

1. To understand the fundamentals of supply chain management and Logistics
2. To develop an understanding related to Supply Chain Performance and related aspects
3. To understand Inventory management in supply chain
4. To learn tools and techniques used in logistics, transportation, warehousing and outsourcing decisions.
5. To develop critical understanding towards digitization in supply chain management and sustainability
6. To develop analytical and critical understanding for planning and designing supply chain network.

Outcomes: Upon successful completion of this course, the learner will be able to

1. Demonstrate a sound understanding of Logistics and Supply Chain Management concepts and their role in today's business environment.
2. Identify the drivers of supply chain performance and risks in supply chain management.
3. Apply various techniques of inventory management and rank the items using inventory management technique
4. Apply various strategies and techniques to minimize overall logistics cost
5. Understand the role of digitization in supply chain management leading to sustainability
6. Apply various mathematical models/tools to design the supply chain network

Module	Contents	Hours
1.	Introduction: Objectives of a Supply Chain Management, Stages of Supply chain, Value Chain Process, Cycle view of Supply Chain Process, Key issues in SCM, logistics & SCM, Supply Chain Drivers /decisions and obstacles, Supply chain strategies, strategic fit, Best practices in SCM, Obstacles of streamlined SCM. Supplier Selection, Supplier quality audits, Contract management, Non-Disclosure Agreement (NDA), Make & Buy Decision while in-out sourcing	05
2.	Supply Chain Performance: Bullwhip effect and reduction, Performance measurement: Dimension, Tools of performance measurement, SCOR Model. Demand chain management, Global Supply chain- Challenges in establishing Global Supply Chain, Factors that influences designing Global Supply Chain Network. Supply Chain Risk Management (Risks involved in supply chain which includes – Supplier Financial Risk, Performance Risk, Compliance Risk, Country specific Risk, Cyber Security. Supplier performance measurement – (Delivery & Quality performance, schedule adherence, Goods receipt compliance etc), Supplier Capacity Analysis, Supplier Score card.	09

3.	Inventory management: Definition of Inventory, Inventory types & functions; EOQ Model and Buffer Stock, Assumptions, Instantaneous Replenishment case, Demand and production rate are different, when backorders are allowed, Buffer Stock and ROL. Replenishment systems (Q and P system) Inventory Control- ABC Analysis, Numerical problems on ABC analysis, VED Analysis	06
4.	Logistics Management and outsourcing: Evolution, Objectives, Components and Functions of Logistics Management, Distribution related Issues and Challenges; Gaining competitive advantage through Logistics Management, Transportation- Functions, Costs, and Mode; Network and Decision, Containerization, Cross docking. Warehousing: Concept and types, Warehousing strategy, Warehouse facility location & network design Part Packaging, Use of Returnable pallets, ASN – Advance Shipment Notification. Reverse logistics: Outsourcing - Nature and concept, Strategic decision to Outsourcing, Third party logistics(3PL), Fourth party logistics(4PL), Cold chain operations in Supply chain.	08
5.	Digitization in supply chain Management and Sustainability: IT in supply chain - Role of IT in a supply chain, The supply chain IT framework, Application of Bar coding, Significance of SAP/RFID, The future of IT in the supply chain, Supply chain IT in practice, TMS (Transport Management System), WMS (Warehouse Management System) Green supply chain management, Supply Chain sustainability, Supply Chain sustainability index measurement with case studies. Social aspects of supply chain (CSR), Environment aspects of supply chain (CO2 emission), resource utilization, recycling.	04
6.	Supply Chain Network Design: Factors influencing distribution network design, Supply chain resilience, Design options for distribution network, Introduction to mathematical modelling, considerations in modelling SCM systems, Overview of the models, Models on transportation, Transportation problem, Vehicle routing problem, Travelling salesman problem, Capacitated transshipment problem, shortest path problem. Value Stream Mapping (VSM), Order Fulfillment Process Flow, understanding the terms related to Supply chain- Lead Time, Takt Time, Minimum Order Quantity (MOQ), Manufacturing Critical Path Time (MCT)	07

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

University of Mumbai

B. E. (Mechanical Engineering), Rev 2019

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

Text/Reference Books: -

1. R.P. Mohanty, S.G. Deshmukh, “Essentials of Supply Chain management”, 1st Edition 2004, Jaico Publishing House.
2. S.K. Bhattacharya, “Logistics Management”, 3rd Edition, Pearson Publication ISBN: 9788131768624
3. Sunil Chopra, P. Meindl, “Supply Chain Management”, 6th Edition 2016, Pearson Education Asia.
4. Martin Christopher, “Logistics and Supply Chain Management”, 4th Edition 2010, Pitman Publishing.
5. Bowon Kim, “Supply Chain Management in Mastering Business in Asia”, Edition 2005, John Wiley & sons (Asia) Pvt Ltd, ISBN: 978-0470821404
6. Michael Hugos, “Essentials of Supply Chain Management”, 4th Edition 2018, John Wiley and Sons, ISBN: 9781119461104
7. Rahul V Altekhar, “Supply Chain Management: Concepts and cases”, Edition 2009, PHI, ISBN: 9788120328594.
8. D. Simchi-Levi, P. Kaminsky, E. Simchi-Levi, and Ravi Shankar, “Designing and Managing the Supply Chain concepts, Strategies and Case studies”, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.

Links for online NPTEL/SWAYAM courses:

1. https://onlinecourses.nptel.ac.in/noc22_mg74/preview
2. https://onlinecourses.swayam2.ac.in/cec22_mg22/preview

Course Code	Course Name	Credits
MEDLO7031	Automotive Power Systems	03

Objectives:

1. To familiarize with the working of S.I. and C.I. engines and its important systems
2. To provide insight into the harmful effects of engine pollutants and its control
3. To familiarise with the latest technological developments in engine technology

Outcomes: Learner will be able to...

1. Demonstrate the working of Fuel supply and ignition system of I.C. engines
2. Illustrate the working of lubrication, cooling and supercharging systems.
3. Comprehend the different technological advances in engines and alternate fuels
4. Identify and describe the history and different EV/HEV drivetrain topologies
5. Compare and evaluate various energy sources and energy storage components for EV and HEV application.
6. Comprehend EV and HEV working through Case studies.

Module	Details	Hours
1.	Constructional Features of I.C. Engines. Parts of I.C. engine and their materials. Fuel Supply System : Fuel-Air ratio, Fuel air mixture requirement, Conventional fuels used in IC engines, Fuel injection system in SI and CI engine and MPFI Engine. Ignition System : Battery Ignition System, Magneto Ignition System, Functions and working of ignition coil, spark plug, contact breaker point, Requirements and working of Ignition advance mechanisms; mechanical and vacuum, Electronic Ignition Systems; Capacitor Discharge Ignition System, Transistorized Coil Assisted Ignition System, Transistor Ignition system with contactless breaker.	08
2.	Lubrication System : Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems	06

	Cooling System : Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling Supercharging/Turbocharging : Objectives, Limitations, Methods and Types, Different arrangements of turbochargers and superchargers (No Numericals)	
3.	Engine Exhaust Emission and its control Constituents of exhaust emission at its harmful effect on environment and human health, Formation of NO_x, HC, CO and particulate emissions, Methods of controlling emissions; Catalytic convertors, particulate traps, Exhaust Gas Recirculation, EURO and BHARAT norms. Alternative Fuels Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas – Biodiesel- Biogas - Producer Gas - Properties - Suitability - Engine Modifications - Merits and Demerits as fuels. Basics of Electronic Engine Controls: Electronic Control module (ECM), Inputs required and output signals from ECM, Sensors: Throttle Position, Inlet Air Temperature, Coolant Temperature, Crankshaft Position, Camshaft Position, Mass Air flow and Exhaust Gas Oxygen sensors, their construction and importance in ECM. Electronic Spark control, Air Management system, Idle speed control	08
4.	Introduction to Hybrid and Electric Vehicles: History of Electric Vehicles (EV) and Hybrid electric vehicles (HEV), need and importance of EV and HEV, Indian and Global Scenario of EV and HEV. Drivetrain topologies: Electric traction and hybrid traction system, Electric drive topologies, hybrid drivetrain topologies. Power energy supply requirement for EV/HEV applications.	06

5.	Electric Drives and controller: Electric system components for EV/HEV, AC and DC motor drives, RPM and Torque calculation of motor, Motor Controllers,	05
6.	Energy Sources for EV/HEVs: Requirement of energy supplies and storage in EV/HEV, Types of batteries(Lead Acid/Li-ion/NiMH) and its working, battery specifications, Battery Management system; Fuel cells, flywheels and ultra-capacitors as energy sources for EV/HEV, Concept of Hybridisation for different energy sources. Energy Management Strategies: EV/HEV energy management strategies, classification and comparison of various energy management strategies Battery charging: Type of battery charging systems, Selection and Sizing of charging station, Components of charging station. Single line diagram of charging station, On board Charger. Payback period of EV and HEV Case Study: Toyota Prius, Honda Insight, Tata Nexon EV	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

Text Books:

1. A Course on Internal Combustion Engine, Mathur and Sharma, Dhanpat Rai & Sons, New Delhi, 2001.
2. Internal Combustion Engine, V. Ganesan, Mc Graw Hill, 1995
3. Internal Combustion Engine, Domkundwar & Domkundwar, Dhanpat Rai & Sons, New Delhi, 2013.
4. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, CRC Press, 2005

Reference Books:

1. Fundamental of Internal Combustion Engines, Gill and Smith, Oxford & IBH Publishing Company Pvt. Ltd, 2007
2. Internal Combustion Engine Fundamentals, Heywood, McGraw Hill, 1988
3. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press, 2003
4. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley, 2003

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/107106088>
2. <https://nptel.ac.in/courses/112103262>
3. <https://nptel.ac.in/courses/108102121>
4. <https://nptel.ac.in/courses/108106170>

Course Code	Course Name	Credits
MEDLO7032	Renewable Energy Sources	03

Objectives:

1. To study working principles of various renewable energy sources and their utilities.
2. To study design and installation criteria of various equipment's to convert the renewable energy into useful energy.
3. To study economics of harnessing energy from renewable energy sources.

Outcomes: Learner will be able to...

1. Describe the need for renewable energy and its potential for the development of a sustainable environment.
2. Analyze different solar collectors using geometrical parameters and photovoltaics for generation of solar energy.
3. Identify and analyze various wind turbine energy harnessment techniques.
4. Design biogas plant for harnessing energy from organic waste.
5. Describe significance of hydrogen energy to fulfill present and future energy needs.
6. Describe the operating principle of geothermal energy and ocean energy and their role in sustainable development.

Module	Contents	Hours
1	1.1: Introduction to Renewable Energy Sources and Solar Radiation: Global and National current energy scenarios, Prospects of renewable energy sources and renewable energies role in developing sustainable model. 1.2: Solar radiation terms, solar geometry, earth sun angles, attenuation and measurement of solar radiation on horizontal and inclined surfaces, methods of solar radiation estimation.	05
2	Solar Thermal Energy: 2.1: Introduction and working principle of flat plate collectors, thermal performance analysis of flat plate collectors, concentrating collectors, Installation and maintenance criteria of solar thermal systems.	07

	2.2: Solar thermal devices- Solar air heater and different types of solar air heaters, solar water heater and different types of solar water heaters, solar dryers, solar pond, solar distillation, solar still, solar cooker. 2.3: Solar space heating & cooling, solar refrigerator, solar thermal energy storage systems. Case Study: Solar thermal power plant working operation.	
3	Solar Photovoltaic Energy: 3.1: Introduction and working principle of a solar PV systems, types of solar PV cells, solar tracking systems, controls and measurement methods of solar PV systems. 3.2: Methods to improve the efficiency of PV cells, parameters which affect the efficiency and life cycle of PV cells. Case Study: Installation of 1 kW of solar PV plant.	07
4	Wind Energy: 4.1: Basic components and working principle of wind energy conversion systems, wind data and site selection considerations, various types of wind energy conversion systems, constructional features of horizontal and vertical axis wind machines, performance analysis of horizontal and vertical axis wind machines. 4.2: Estimation of power output- betz limits, Environmental impacts of wind energy.	06
5	5.1: Energy from Biomass: Introduction of bioenergy, conversion technologies, types of biogas generation plants, design and construction details of biogas plant (KVIC), site selection, digester design consideration, filling a digester for starting, maintaining biogas production, utilization of biogas.	07

	5.2: Hydrogen Energy: Introduction and application, General introduction to infrastructure requirement for hydrogen production, storage, dispensing & utilization. Principles of fuel cells, types of fuel cells, power generation by fuel cells, applications of fuel cells.	
6	6.1: Geothermal Energy: Introduction to geothermal technologies and methods of extracting geothermal energy, prospects of geothermal energy in India. 6.2: Energy from the ocean: Wave energy characteristics and wave energy conversion devices, tide energy conversion devices, Ocean Thermal Energy Conversion (OTEC) systems. 6.3: Energy management and economics: Energy conservation, energy security, energy economics, energy audit- definition, need, types of energy audit, Energy management (audit) approach-understanding energy costs, Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating.	07

Visit to wind farm/solar plant/biogas plant.

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**

3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only Four questions need to be solved.

Reference Books:

1. “Non-conventional Energy Sources”, G.D. Rai, 6th Edition, Khanna Publishers, ISBN: 978-81-7409-073-7
2. “Renewable Energy: Power for a Sustainable Future”, Edited by Godfrey Boyle, 3rd Edition 2012, Oxford University Press, ISBN: 978-0199681273
3. “Solar Energy: Principles of Thermal Collection and Storage”, SP Sukhatme and J K Nayak, 4th Edition, Tata McGraw Hill Publishing Co. Ltd.
4. “Solar Energy: Fundamentals and Applications”, H.P. Garg & Jai Prakash, First Revised Edition, Tata McGraw-Hill Education.
5. “Wind Power Technology”, Joshua Earnest, 2nd Edition, PHI Learning, 2015.
6. “Solar Engineering of Thermal Processes”, John A. Duffie and William A Bechman, 4th Edition, Wiley Publications.
7. “Renewable Energy Sources”, J W Twidell & Anthony D. Weir, 3rd Edition 2015, ELBS Pub, ISBN: 978-1-315-76641-6
8. “Energy Conversion Systems”, Rakosh Das Begamudre, New Age International (P) Ltd., Publishers, New Delhi, 2007, ISBN: 9788122412666
9. “Solar Photovoltaics: Fundamentals, Technologies and Applications”, C S Solanki, 3rd Edition, PHI Learning.
10. “Biomass Regenerable Energy”, D. D. Hall and R. P. Overend, John Wiley, New York, ISBN: 047190919X
11. “Wind and Solar Power Systems”, Mukund R Patel, 2nd Revised Edition, CRC Press, ISBN: 9780429114960
12. “Wind Energy Explained: Theory, Design and Application”, J F Manwell, J.C. McGowan, A.L. Rogers, 2nd Edition 2009, John Wiley and Sons.

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/103103206>
2. <https://nptel.ac.in/courses/103107157>
3. <https://nptel.ac.in/courses/115105127>

Course Code	Course Name	Credits
MEDLO7033	Vehicle Systems	03

Objectives:

1. To study basic and advanced vehicle systems
2. To study basic and advanced vehicle electrical systems
3. To study different chassis structures components.
4. To familiarize with the latest technological developments in automotive technology

Outcomes: Learner will be able to

1. Understand the working of different Vehicle Systems and Subsystems.
2. Understand the working of different Vehicle Electrical systems and subsystems.
3. Understand different Vehicle Body systems and layouts.
4. Illustrate working, functions of different vehicle mechanical, electrical, and chassis systems.
5. Understand the effect of aerodynamics on the functioning of a vehicle.
6. Comprehend the different technological advances in vehicle systems.

Module	Details	Hours
1.	Power Flow Layout: FE FWD,FE RWD,RE FWD,RE RWD, Underfloor Engine Clutches: Necessity of clutch in a automobile, Working and Construction of Single plate, Multi plate, Centrifugal, Semi Centrifugal, electromagnetic clutches, Fluid Flywheel Transmission: Purpose and Elements of Gear Box, Characteristic Curves, Types-Sliding mesh, Constant Mesh, Synchromesh, Planetary Gear set, Torque Converter, Semi-Automatic and Automatic Drive Line:	08

	UV joint, CV joint, Propeller Shaft construction and arrangement, Elements of drive line, 2WD, 4WD, Part time and Full time 2WD and 4WD.	
2.	Final Drive Types of Final drive; spiral, bevel, Hypoid and worm drives. Differential Necessity of differential, Working of differential, Conventional and non-slip differential. Axles : Types of live axles; semi, three quarter and full floating axles. Types of Front Stub Axles; Elliot, Reverse Elliot, Lamoine and Reverse Lamoine Steering: Requirement, Types of Steering Gear Box, Steering Geometry, Wheel Alignment and Wheel balancing, Power Steering Brakes: Principle, Types; Hydraulic, Air, Electric, Exhaust, Regeneration , Brake lining materials, ABS, EBD	08
3.	Suspension: Requirement and Types-Independent, Dependent, Air. Types of Shock absorbers , Leaf spring types Wheels and Tyres: Tyre requirement, tire characteristics, Constructional detail, , tyre dimensions and specifications, Types of wheels and Hubs	06
4.	AUTOMOTIVE ELECTRICAL SYSTEMS Batteries: Construction, Types: Lead Acid, Alkaline, Nickel Metal Hydride, Lithium Ion, Battery Ratings, Battery Charging Starting:	08

	Requirement, Starter Motor Drives, cold cranking Amperes Charging: Requirement, Principle and Construction of Dynamo and Alternator Ignition: Mechanical and Electronic Ignition and Electronic Engine Control Lighting and Wiring: Types of Lamps, Gauges, Cable Sizes, Color Codes, Multiplex Wiring systems Accessories: Electric Horn, Wipers, Fuel Pumps, Power operated windows, Fuel Gauges, OBD systems	
5.	Body Engineering: Chassis types and Structure types-Open, Semi Integral and Integral, Loads acting on chassis, Basic Dimensions and Visibility Vehicle Aerodynamics : Aerodynamic drag: Aerodynamic lift and Pitching moments, Side force, Yawing & Rolling moments.	06
6.	Recent Technological Developments in Automobile: Telematics, Intelligent Vehicles systems, V2V and V2I communication. Scope of AI in Automobile Vehicle	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

Text Books:

1. Automobile Engineering, Kirpal Singh, Vol I & II, Standard publishers Distributors ,Delhi
2. J Powloski, "Vehicle Body Engineering", Business Books Ltd., London
3. Automobile Mechanics, N. K. Giri, 8thEdition, Khanna Publishers
4. P. L. Kohli, "Automotive Chassis & Body", Papyrus Publishing House, New Delhi.
5. Tom Denton, Automobile Electrical and Electronics System, Elsevier Third Edition, 2003

Reference Books :

1. John Fenton, "Vehicle Body Layout & Analysis", Hutchinson, London.
2. Bosch Automotive HandBook, 6thEdition, SAE Publications
3. Automotive Mechanics by William H. Crouse and Donald L. Anglin, 10th Edition, McGraw Hill

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/107106088>
2. <https://nptel.ac.in/courses/107103084>
3. <https://nptel.ac.in/courses/113106082>

Course Code	Course Name	Credits
MEDLO7041	Machinery Diagnostics	03

Objectives :

1. To study basic concepts of Vibration Monitoring.
2. To study different Vibration Measuring Instruments.
3. To study fault detection in Machines using vibration spectrum.

Outcomes: Learner will be able to...

1. Relate basic concepts of Machinery Diagnostic.
2. Describe the working of Vibration Measuring Instruments.
3. Apply different Signal Processing Techniques in Vibration Measurement.
4. Identify common faults in Machinery using Vibration Spectrum.
5. Interpret the Vibration Signals for Monitoring and Prognosis.

Module	Contents	Hours
1	1.1 Basics of Vibration Periodic and random motion, Spectral Amplitude Scaling: RMS, Peak and Peak-to-Peak Conversion and Selection, Time and frequency domain analysis, Phase analysis, Orbit analysis, Understanding signal pattern, Importance of speed in accurate diagnosis, Importance of side bands in frequency spectrums. 1.2 Introduction to Vibration based Condition Monitoring Maintenance Principles, Vibration based fault Prognosis, Goal of Vibration Monitoring, Steps in Vibration Monitoring, Benefits of Vibration based condition monitoring.	07
2	Vibration Measurement Vibration measuring instruments: displacement, velocity, acceleration; Force measurement, Laser based measurements: laser vibrometer Sensor Selection Criteria , Sensor – Mounting Locations and Techniques	07
3	Data Acquisition & Signal Processing Classification of signals, Signal analysis, Fast Fourier Transform (FFT), Essential Settings in Data Acquisition System (Plot Formats, Frequency Span and Frequency Resolution, Average Types and Number of Averages, Windowing, Spectrum Scaling), Signal conditioning	07
4	Machinery Fault Diagnosis I Natural frequency and resonance tests (Practical approach), Time and Frequency domain analysis to identify unbalance, bent shaft, Misalignment, Soft foot conditions, Mechanical looseness	06

5	Machinery Fault Diagnosis II Rolling element bearing and Journal Bearing fault diagnosis, Faults related to Gearbox, vane defects in pumps, Fault in Fans and Blowers.	06
6	Applications of Condition Monitoring Case studies related Balancing Problems in Turbines, Condition Monitoring in Sugar mills, Health Monitoring of Journal Bearing, Condition Monitoring of Industrial Pumps. (Aspects to be covered : Selection of sensors, recommended location of sensor, direction of measurement, selection of plot type, Data validation and Identification of Faults)	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

Text/Reference Books:

1. R.B. Randall, “Vibration-based Condition Monitoring”, Wiley 2021, ISBN: 978-1-119-47755-6
2. A.R. Mohanty, “Machine Condition Monitoring: Principles and Practices”, CRC Press 2017, ISBN: [9781138748255](#)
3. R.A. Collacott, “Mechanical Fault Diagnosis and Condition Monitoring”, 1st Edition, Chapman and Hall, ISBN: 978-94-009-5723-7
4. J.S. Rao, “Vibratory Condition Monitoring of Machine”, Narosa Publishing House.

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112105232> – Machinery Fault Diagnosis and Signal Processing, IIT, Kharagpur

Course Code	Course Name	Credits
MEDLO7042	Vibration Controls	03

Objectives :

1. To study Vibration Absorbers.
2. To study Vibration Isolators.
3. To study Vibration Control.

Outcomes: Learner will be able to...

1. Apply basic concepts of Vibration Isolation and Damping.
2. Identify suitable Vibration Absorber
3. Identify suitable Vibration Isolator
4. Apply suitable method to Control the vibrations to the acceptable level.

Module	Contents	Hours
1	1.1 Introduction: Vibration reduction at source, factors affecting vibration level, isolation of the source, methods of vibration control, dynamic properties and selection of materials	05
2	2.1 Dynamic vibration absorbers: Dynamic vibration neutralizers, self-tuned pendulum neutralizer, optimum design of damped absorbers, absorber with ideal spring and viscous dashpot, gyroscopic vibration absorbers, impact absorbers, absorbers attached to continuous systems	08
3	3.1 Vibration isolation of single degree of freedom systems: Isolators with complex stiffness, Isolators with Coulomb damping, Three-element isolators, Two-stage isolators, Pneumatic suspension, Concept of negative stiffness in vibration isolation	08
4.	4.1 Active vibration control: Classification and modelling, actuators and sensors for active vibration control, Active vibration absorption and damping, classical control, optimal control, Piezoelectric transducers for active vibration control 4.2 Semi-active vibration control: Introduction, Magneto-rheological fluids, MR models and devices, semi-active suspension, narrowband disturbance	08

5	5.1 Active, semi-active, and adaptive dynamic vibration absorbers: Active tuned vibration absorber, active mass damper, adaptive vibration absorber, semi-active tuned vibration absorber	05
6	6.1 Active and semi-active vibration isolation: Active single-axis base isolation, active force isolation system, isolator based on piezoelectric stack actuator, semi-active isolation, Adaptive-passive vibration isolation, active control of vehicle suspensions	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

5. Question paper will comprise of total **six questions, each carrying 20 marks.**
6. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
7. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
8. Only **Four questions need to be solved.**

Text/Reference Books:

1. A.K. Mallik and A. Chatterjee, "Principles of Active and Passive Vibration Control", East-West-Press 2014, ISBN: 9788176710985
2. A. Preumont, "Vibration Control of Active Structures", Springer 2018, ISBN: 9783319722962
3. S.S. Rao, "Mechanical Vibrations", 5th Edition 2004, Pearson Publications
4. Clarence de Silva, "Vibration: Fundamentals and Practice", 1st Edition 2000, CRC Press, ISBN: 0849318084

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112104211>– Principles of Vibration Control, IIT Kanpur

<https://nptel.ac.in/courses/112107088>– Vibration control, IIT Roorkee

Course Code	Course Name	Credits
MEDLO7043	Advanced Vibration	03

Objectives :

1. To study the Multi-degree of freedom system.
2. To study different vibration measurement and control methods, and required instruments.
3. To study basic concepts of Random Vibrations.
4. To study the basic concepts of nonlinear vibrations.

Outcomes: Learner will be able to...

1. Estimate natural frequency of mechanical element / system.
2. Understand the concepts of Vibration Isolation and Control.
3. Analyse vibratory response of mechanical element / system.
4. Analyse vibration of Continuous system.
5. Analyse Random Vibrations.
6. Analyse Non-Linear Vibrations.

Module	Contents	Hours
1	Multi Degree of Freedom System: 1.1 Undamped free vibration: Free vibration equation of motion, Influence coefficients (stiffness and flexibility), Reciprocity theorem, Generalized Coordinates, and Coordinate Coupling, Lagrangian equations, Rayleigh and Dunkerley method, two rotor and geared systems 1.2 Eigen Values and Eigen vectors: for translatory and torsional two d.o.f. systems, Matrix method, Holzer's method (translatory and torsional unbranched systems)	06
2	2.1 Vibration Isolation and Control: Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers, and Vibration dampers, Passive, semi-active, and active vibration control	06
3	3.1 Vibration Measurement: Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis. 3.2 Modal analysis and Condition Monitoring: Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine condition monitoring and diagnosis.	06
4	Vibration of Continuous Systems: Vibration of string, Longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.	07
5	Random Vibrations: Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms and response.	07
6	Non-Linear Vibrations: Introduction, Sources of nonlinearity, Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations, Runge-Kutta method.	07

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

Text/Reference Books:

1. W.T. Thomson and M.D. Dahleh, “Theory of Vibration with Applications”, 3rd Edition 2002, Pearson Education
2. G.K. Grover, “Mechanical Vibrations”, 5th Edition 2009, Nem Chand and Bros, ISBN: **978-8185240565**
3. W.W. Seto, “Mechanical Vibrations- Schaum's Outline Series”, McGraw Hill, ISBN: [9780070563278](https://www.mhprofessional.com/9780070563278)
4. S.S. Rao, “Mechanical Vibrations”, 5th Edition 2004, Pearson Publications
5. Leonard Meirovitch, “Fundamentals of Vibration”, 1st Edition 2010, McGraw Hill, ISBN: 978-1577666912.

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112107212> – Introduction to Mechanical Vibration, IIT Roorkee
<https://nptel.ac.in/courses/112103111> – Mechanical Vibrations, IIT Guwahati
<https://nptel.ac.in/courses/112103022> – Nonlinear Vibration, IIT Guwahati
<https://nptel.ac.in/courses/112104211> – Principles of Vibration Control, IIT Kanpur

Course Code	Course Name	Credits
ILO7011	Product Life Cycle Management	03

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to...

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant
- 5.

Sr. No.	Detailed Contents	Hrs
01	Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques,	05

	Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
05	Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO7012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to...

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Sr. No.	Detailed Contents	Hrs
1	Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
2	Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
3	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
4	Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
5	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
6	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillon, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Connor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to...

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Sr. No.	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to...

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Sr. No	Detailed Contents	Hrs
01	Introduction 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	Fitting Regression Models 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	Two-Level Factorial Designs 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	Two-Level Fractional Factorial Designs 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design	07

	4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	
05	Response Surface Methods and Designs 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
06	Taguchi Approach 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to...

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Sr. No.	Detailed Contents	Hrs
01	Introduction to Operations Research: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	Queuing models: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05

03	Simulation: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	Dynamic programming. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	Inventory Models: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Lieberman, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Course Code	Course Name	Credits
ILO7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognize Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to...

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Sr. No.	Detailed Contents	Hrs
01	Introduction to Cybercrime: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	Cyber offenses & Cybercrime: How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	Tools and Methods Used in Cyberline Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	The Concept of Cyberspace E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8

05	Indian IT Act. Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	Information Security Standard compliances SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneth J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : <https://www.tifrh.res.in>
9. Website for more information , A Compliance Primer for IT professional : <https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538>

Course Code	Course Name	Credits
ILO7017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to...

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Sr. No.	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06

04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to...

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Sr. No	Detailed Contents	Hrs
01	Energy Scenario: Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	Energy Audit Principles: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	Energy Management and Energy Conservation in Electrical System: Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers.	10

	Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	Energy Management and Energy Conservation in Thermal Systems: Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Development Engineering	03

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to...

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Sr. No.	Detailed Contents	Hrs
01	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
02	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	04
03	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	06

04	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
05	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	10
06	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

References:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Course Code	Course Name	Credits
MEL701	DESIGN OF MECHANICAL SYSTEMS	01

Objectives:

1. To familiarize with the concept of system and methodology of system design
2. To study system design of various systems such as Gear box, snatch block, belt conveyors, I. C. engine system and pumps
3. To familiarize with the standard codes of professional practices in designing the various systems

Outcomes: Upon successful completion of this course, the learner will be able to ...

1. Apply the concept of system design.
2. Design of Gear box.
3. Design of hoisting mechanism of EOT crane,
4. Design belt conveyor systems
5. Design engine components such as cylinder, piston, connecting rod and crankshaft
6. Design pumps for the given applications

Term Work:	Comprises of Part - A & Part -B
Module	Details
Part A	1. DESIGN AND DETAILED ASSEMBLY DRAWING :
	a) Computer aided Design and detailed assembly drawing (A3 size sheets) of any one design problem, from any CAD software
	i) Design of hoisting mechanisms
	ii) Design of belt conveyors
	iii) Design of Engine
	b) Design and detailed assembly drawing (Full Imperial drawing sheet 762x559 mm) of any one design problem from the following:
	i) Design of Gear box
	ii) Design of pumps
	2. COURSE PROJECT :
	Students in a group of two to four should be able to apply and integrate the knowledge gained during the course. Design and preparation of working drawings of any system having minimum 5 to 6 components is expected. Course project may be given as development of software program using python, VB, C++, EXCEL etc for mechanical systems
Part B	ASSIGNMENT :
	Exercises on following topics in the form of design calculations with sketches and / or drawings.
	1. Methodology & Morphology of design
	2. Design of gearbox (As mentioned in theory)
	3. Design of Hoisting mechanism
	4. Design of Belt conveyor

	5. Engine design (SI/CI engine)
	6. Design of Pump
	The distribution of marks for term work shall be as follows:
	☐ Exercises and Drawing sheets : 10 marks.
	☐ Assignments : 05 marks
	☐ Course Project : 05 marks.
	☐ Attendance : 05 Marks.
	ASSESSMENT :
	End Semester Practical/Oral examination:
	1. Each student will be given a small task of design based on syllabus, which will be assessed by pair of examiners during the oral examination.
	2. Distribution of marks for practical-oral examination shall be as follows:
	Design Task : 15 marks
	Oral : 10 marks
	3. Evaluation of practical/oral examination to be done based on the performance of design task
	4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL702	Maintenance Engineering Lab	1

Objectives

1. To familiarize with Maintenance Procedures and Strategies.
2. To acquaint with the process of Condition Monitoring and Machinery Fault Diagnosis.

Outcomes: Learner will be able to....

1. Identify different tools used for maintenance.
2. Apply different maintenance strategies.
3. Demonstrate the process of servicing a machine.
4. Identify common faults in Machinery using Vibration Spectrum.
5. Interpret the Vibration Signals for Monitoring and Prognosis.

Sr. No.	List of Exercises
1.	Identifications of different Tools used for maintenance (Spanner, Plier, Screw Driver, Allen Keys, Puller etc.)
2.	Dismantling and assembly of any one mechanical system (Gearbox, pumps, Injector, Fuel Pump, Tailstock etc.) (One job in a group of 4-5 students)
3.	Case studies based on Maintenance strategies (Breakdown, preventive, predictive and proactive)
4.	Machinery Servicing (Greasing, Oiling, Cleaning etc.)
5.	Condition Monitoring and Machinery Fault Diagnosis – Unbalance
6.	Condition Monitoring and Machinery Fault Diagnosis – Misalignment
7.	Condition Monitoring and Machinery Fault Diagnosis – Bent Shaft
8.	Condition Monitoring and Machinery Fault Diagnosis – Mechanical Looseness
9.	Condition Monitoring and Machinery Fault Diagnosis – Bearing Defects
10.	Condition Monitoring and Machinery Fault Diagnosis – Defects in gears
11.	Condition Monitoring and Machinery Fault Diagnosis – Defects in pumps
12.	Condition Monitoring and Machinery Fault Diagnosis – Defects in fans
13.	Condition Monitoring and Machinery Fault Diagnosis – Defects in blowers

Note :

1. First four experiments are mandatory. At least four experiments to be performed from the remaining.
2. A visit of students to an automobile service station/any other machinery maintenance workshop shall be arranged as a part of the above exercises.

Assessment:

Distribution of marks for term work

Laboratory work 20 Marks

Attendance 05 Marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:
 - a. Practical performance 15 marks
 - b. Viva 10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination.

References:

1. A.R. Mohanty, “Machine Condition Monitoring: Principles and Practices”, CRC Press
2. R.A. Collacott, “Mechanical Fault Diagnosis and Condition Monitoring”, Chapman and Hall

NPTEL

<https://nptel.ac.in/courses/112105232> – Machinery Fault Diagnosis and Signal Processing, IIT Kharagpur

Course Code	Course Name	Credits
MEL703	Industrial Skills	01

Course Rationale: This course has been designed to prepare final year mechanical engineering students for placements, as well as to build computer skills and advanced soft skills to make them ready for a career in the industry.

Objectives:

1. To familiarise mechanical engineering students with basic computer/IT skills in the industry.
2. To practise soft skills and communication to be industry-ready.
3. To inculcate critical thinking and problem-solving abilities for efficient team and project outcomes.
4. To be prepared for campus placements by practising aptitude, logical reasoning, Group discussion and personal interview rounds.

Outcomes: At the end of the course, **the learners will be able to**

1. Skilfully prepare and edit documents and slides on MS Word and MS PowerPoint etc.
2. Execute functions on MS Excel.
3. Learn how to navigate tasks and execute functions in G-suite.
4. Understand and practice metacognitive skills of creativity and problem solving.
5. Hone team building and leadership skills.

Perform well in campus placement rounds by practising Aptitude, Logical reasoning, Group Discussion and Personal Interviews.

Module	List of Experiments and Activities	No. of Lab sessions (*2hrs)
1	Computer/IT skills	6
1.1	Basics of Computers- Desktop/Laptop operations	
1.2	Microsoft Office	
1.2.1	• MS Word- Assignment to Create and use various commands in a Word document (Page setup, text formatting, templates, SmartArt, Title and Ribbon bar, Editing etc.)	
1.2.2	• MS Excel- Assignment to Create and tabulate a spreadsheet (Excel- data analysis, charts, pivot tables, VBA, etc.)	
1.2.3	• MS- Power point- Assignment to design and use a Presentation Software(MSPPT, Prezi, etc. – Presentation	

1.2.4	design, templates, custom slides, animation, graphs, charts, troubleshooting etc.) • MS Outlook (Navigation, archiving, tasks distribution, filters, scheduling etc.)	
1.3	• G-Suite (Gmail, G-Meet, Calendar, Sheets, Docs, Slides etc.)	
1.4	• An introduction to the typesetting package LATEX.	
2	Aptitude and Logical Reasoning	2
2.1	Aptitude – Aptitude training, types of questions, mock tests	
2.2	Logical Reasoning – Verbal and Non-verbal reasoning, Types of questions, Mock tests	
3	Developing Metacognitive skills	2
3.1	Task orientation and Goal setting (can be based on Final year Project):	
3.2	Creativity and Problem-solving	
4	Collaborative Techniques: Team building skills	1
4.1	Activities on Team building	
4.2	Case studies on Leadership, Decision making and Team building	
5	GD – PI	2
5.1	Group Discussion – Factual, Strategic, Abstract, Case study, Picture based	
5.2	Personal Interview–Types of Interview Questions, Strategies, Sample answers, Mock Interviews	

Assignments: Assignments and activities should enable a steady progress in developing the aforementioned skills. A record of the conducted activities can be attached in journal as image printouts, and write up of case studies.

1. Application of MS Office skills (Individual)
 - Create and edit Word documents
 - Create and execute MS Excel functions
 - Create and enhance MS PPT
2. Writing a simple document in LATEX editor and running the typesetter program to produce finished document
3. Aptitude and Logical reasoning tests/practice sheets

4. Team building skills: Activities/Tasks to be performed as a team of 3 or 4 students.
5. Group Discussions

Case studies on problem-solving to be done as a team activity.

Personal Interview questions log book

Assessment: Total – 50 Marks

Marks distribution will be as follows:

FINAL TERM WORK – 25 Marks

Assignments (Journal) – 20 Marks

Attendance - 05 Marks

ORALS/Written – 25 Marks

1. **Aptitude Test (Written) - 15 Marks**
2. **Mock Interview (Orals) – 10 Marks**

Books recommended/References/ Resources:

1. Meenakshi Raman, Prakash Singh. *Business Communication*, Oxford University Press, 2012
2. Claudyne Wilder. *The Presentations Kit: 10 steps for Selling Your Ideas*, John Wiley & Sons, 1994.
3. Lesikar, Flatley. *Basic Business Communication: Skills for Empowering the Internet Generation*, Tata McGraw Hill, 2008.
4. Flavell, J. H. *Cognitive development: Past, present, and future*. 1992.
5. Thorpe, Edgar and Showick Thorpe. *Objective English*, Pearson, 2013. (7th edition Amazon)
6. Thorpe, Edgar. *Test of Reasoning: for All Competitive Examination*. 7th edition., Amazon
7. Sinha, Nishit K., *Reasoning*, Pearson.
8. Aggarwal, R.S., *A Modern Approach to Logical Reasoning*, S. Chand.
9. Weblinks - <https://cambridge-community.org.uk/professional-development/gswmeta/index.html>
10. Various Quantitative aptitude books and websites list <https://eduly.in/best-quantitative-aptitude-books/>
<https://prepinsta.com/learn-aptitude/>
<https://www.simplilearn.com/learn-ms-excel-free-training-course-skillup>

NPTEL

Creativity <https://nptel.ac.in/courses/109101017>

Course Era

MS Excel <https://www.coursera.org/projects/introduction-microsoft-excel>

G-suite <https://www.coursera.org/projects/collaborating-g-suite-apps>

Problem solving <https://www.coursera.org/learn/problem-solving>

Udemy

G-suite <https://www.udemy.com/course/learn-gsuite/>

Course Code	Course Name	Credits
MEP701	Major Project 1	03

Objectives: The course aims:

The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions.

Outcomes:

1	Students will be able to develop the understanding of the problem domain through extensive review of literature.
2	Students will be able to identify and analyze the problem in detail to define its scope with problem specific data.
3	Students will be able to identify various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4	Students will be able to design solutions for real-time problems that will positively impact society and environment..
5	Students will be able to develop clarity of presentation based on communication, teamwork and leadership skills.
6	Students will be able to inculcate professional and ethical behavior..

Guidelines:

1. Project Topic Selection and Allocation:

- Project topic selection Process to be defined and followed:
 - Project orientation can be given at the end of sixth semester.
 - Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
 - Student's should be recommended to refer papers from reputed conferences/ journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
 - Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements. Students can be informed to refer Digital India portal, SIH portal or any other hackathon portal for problem selection.
- Topics can be finalized with respect to following criterion:
 - **Topic Selection:** The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.

- **Technology Used:** Use of latest technology or modern tools can be encouraged.
- Students should not repeat work done previously (work done in the last three years).
- Project work must be carried out by the group of at least 2 students and maximum 4.
- The project work can be undertaken in a research institute or organization/Industry/any business establishment. (out-house projects)
- The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are expert in the domain.
- Head of department and senior staff along with project coordinators will take decision regarding final selection of projects.
- Guide allocation should be done and students have to submit weekly progress report to the internal guide.
- Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.
- In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels

2. Project Report Format:

At the end of semester, each group need to prepare a project report as per the guidelines issued by the University of Mumbai.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey
 - Survey of Existing systems
 - Limitations of Existing systems or research gaps
 - Motivation (Challenges that are encouraging to choose the problem)
 - Problem Statement and Proposed Solution
 - Scope of the system
- Proposed System
 - General Workflow/Block diagram
- Analysis and Modeling (only applicable diagrams)
- Design
 - Architectural View
 - Algorithms/ Methodology
- Experimental Set up
 - Details of Database or details about input to system or selected data
 - Performance Evaluation Parameters (for Validation)
 - Software and Hardware Set up
- Implementation Plan for Next Semester
 - Timeline Chart for Term-I and Term-II (Project Management tools can be used.)
- Summary
- References

Desirable

- Students can be asked to undergo some Certification course (for the technical skill set that will be useful and applicable for projects.)

3.Term Work:

Distribution of marks for term work shall be done based on following:

- a. Weekly Log Report
- b. Project Work Contribution
- c. Project Report (Spiral Bound) (both side print)
- d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. Term work evaluation:

Term work evaluation for Project 1 should be conducted by Internal examiner on continuous basis throughout the semester.

Suggested quality evaluation parameters are as follows:

1. Quality of problem selected
2. Clarity of problem definition and feasibility of problem solution
3. Relevance to the specialization / industrial trends
4. Originality
5. Clarity of objective and scope
6. Quality of analysis and design
7. Quality of written and oral presentation
8. Individual as well as team work

Course Code	Course Name	Credits
MEC801	Operations Planning and Control	03

Objectives:

1. To provide an exposure to Operations Planning & Control (PPC) and its significance in manufacturing and service organizations
2. To appraise about need and benefits of planning functions related to products and processes
3. To provide exposure to production scheduling, sequencing and project management so as to optimize resources
4. To provide insights into MRP and ERP to minimize the total cost and to manage operations functions in a better way
5. To demonstrate different techniques used for facility planning and assembly line balancing
6. To develop an understanding of JIT, Lean, Agile and Synchronous Manufacturing system

Outcomes: Learner will be able to...

1. Illustrate operations functions and manage operations in a better way.
2. Apply various strategies to develop aggregate production plan based on the demand forecasting.
3. Apply various algorithms in scheduling and sequencing of manufacturing and service operations
4. Develop Material Requirements Plans (MRP) to estimate the planned order releases.
5. Apply various techniques for facility layout planning and line balancing to optimize the resources
6. Demonstrate the importance of implementation of JIT, Lean, Agile and Synchronous manufacturing in manufacturing and service organizations.

Module	Contents	Hours
1	1.1 Introduction: Production and Operations Function, Production systems, Make to stock, Make to order, Assemble to order and Engineer to order, type of layouts, Phases in OPC like Preplanning, Planning, Action & Control. 1.2 Strategic Planning for Operations and Services: Approaches like Forced Choice model and Operations Model, Quality and Productivity strategy, Technology strategy. Operations Strategies for Services, Types or Service Operations: Quasi manufacturing, Customer as participants, Customer as product, Classification of Services, Service capacity.	06
2	2.1 Forecasting: Forecasting and Prediction, Need for forecasting, role of forecasting in OPC, Methods of forecasting, Qualitative methods, Quantitative methods like time series analysis, least square method, moving average method, and exponential smoothing method. Forecasting Error; Mean Absolute Deviation, Forecasting Bias 2.2 Capacity Planning: Measurement of capacity, Measures of operating capacity, Factors influencing effective capacity, factors favouring over capacity and under capacity, short range, medium range and long range capacity planning. Capacity requirement Planning (CRP)	08

	2.3 Aggregate planning: Concept of aggregate planning, Pure Strategy; Mixed Strategy; Level Strategy, Rough cut capacity planning, Aggregate planning for Services; Optimal Models for Aggregate Planning; Linear Programming; Linear Decision Rules Master Production Schedule	
3	3.1 Job shop/Intermittent Manufacturing Scheduling: Factors influencing scheduling, Inputs for scheduling, Forward Scheduling, Backward Scheduling, Stages in Scheduling: Product sequencing, Loading and Dispatching, dispatching, progress report & expediting and control. Basic scheduling problems, Priority Sequencing, Gantt Charts, Johnson's Rule for optimal sequence of N jobs on 2 machine. Process N Jobs on 3 Machines (N/3 problem) and Jackson Algorithm. Processing of 2 Jobs on M Machine (2/M) problem, 3.2 Project scheduling: Network analysis - PERT & CPM, cost analysis & crashing, resource leveling and smoothening.	08
4	4.1 Material Requirement Planning: Introduction, Limitations of conventional EOQ, Objectives of MRP, Inputs of MRP-I, Outputs of MRP, MRP lot sizing and Estimation of planned order releases, Manufacturing resource planning (MRP-II) 4.2 Enterprise Resource Planning (ERP): Evolution, features, purpose of modeling an enterprise, ERP model for OPC, Modules in ERP, ERP Implementation Life Cycle, ERP packages like SAP-R3/Baan/PeopleSoft,	06
5	5.1 Facility layout planning: Factors influencing Plant Layout, Material Flow Patterns, Tools and Techniques used for Plant Layout Planning. 5.2 Line Balancing: Objectives, constraints, terminology in assembly line, heuristic methods like Kilbridge-Wester, Largest Candidate rule, Rank positional weight	06
6	Introduction to JIT system, Lean, Agile and Synchronous manufacturing: Concept, Characteristics, Components and Implementation.	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books: -

1. "Production and Operations Management", K. Aswathappa & K. Shridhara Rao, Himalaya Publishing House, Revised 2nd Edition (2008)
2. "Industrial Engineering and Production Management", Martand Telsang, S. Chand, New Delhi (2009)
3. "Modern Production operations Management", Elwood S Buffa and Rakesh K Sarin, 8th Edition, Wiley Eastern, New York (1999) ISBN: 978-0471819059
4. "Production and Operations Management", Panneer Selvan R, 3rd Edition 2002 Prentice Hall India, New Delhi, ISBN: 978-8120345553
5. "Production Planning and Control", Samuel Eilon, Universal Publication, ISBN: 9788185027548
6. "Production Planning and Control", L C Jhamb, 12th Edition 2010, Everest Pub House.
7. "Production Planning and Control", W. Boltan-Longman Scientific & Technical (1994), ISBN: 978-0582228207
8. "Production Systems- Planning, Analysis & Control", James. L. Riggs, John, 4th Edition 1987, Wiley & Sons, ISBN: 9780471847939
9. Manufacturing Planning and Control Systems, Thomas E. Vollman, William L. Berry & Others, 4th Edition 1997, McGraw Hill Pub, ISBN: 978-0786312092
10. "Manufacturing Process Planning and Systems Engineering", Anand Bewoor, Dreamtech Press 2009, ISBN: 978-8177229967
11. "Production and Operations Management", S.N. Chary, 3rd Edition 2004, TMH publishing company, ISBN: 978-0070583559
12. Modernization & Material Management, L.C. Jhamb - Everest Publishing House

Course Code	Course Name	Credits
MEDLO8051	Composite Materials	03

Objectives

1. To study the manufacturing methods of composite material.
2. To study the behaviour of composite materials, both at micro and macro levels.
3. To study the procedure of designing a composite laminate and structure as a whole for the given application.
4. To study the applicability of composite materials for various industrial/loading applications
5. To study the damage detection and damage repair methods for composite materials

Outcomes: Learner will be able to...

1. Select the type of material for the fibres and matrix in a composite material for the given application.
2. Relate stresses and strains through the elastic constants for a given lamina.
3. Evaluate elastic properties of a lamina based on the properties of its constituents.
4. Predict failure of a lamina under the given loading condition.
5. Select the number of laminae and their stacking sequence in a composite material for the given loading condition.
6. Identify the type of damage occurring in a composite structure and select an appropriate method to repair it.

Module	Contents	Hours
1	Introduction Classifications based on fibres and matrix, Advantages, Applications, Terminology, Manufacturing Methods: Hand layup, Spray layup, Vacuum bagging, Prepregs, Industrial autoclave, Filament winding, Pultrusion, Resin transfer moulding, Vacuum Infusion Processing, Powder metallurgy route for ceramic and metal matrix composites	08
2	Analysis of Lamina Hooke's law for different types of materials, Plane stress assumption, Hooke's law for a two-dimensional unidirectional lamina, Relationship of compliance and stiffness matrix to engineering elastic constants of a lamina, Hooke's law for a two-dimensional angle lamina, Engineering constants of an angle lamina	06
3	Lamina Failure Theories Introduction, Maximum stress failure theory, Maximum strain failure theory, Tsai-Hill failure theory, Tsai-Wu failure theory, Strength ratio, Failure envelopes	04
4	Introduction to Micromechanics of Lamina and Laminate Design Prediction of mechanical properties of lamina based on properties of its constituents (fibre and matrix), Laminate types and their codes, Overview of laminate design (no problems on this topic)	06

5	Inspection of Composites Different types of damages in composites, Non-destructive testing of composites: Ultrasonics inspection, Acoustography, Low frequency Methods, Radiographic inspection, Shearography, Acoustic emission, Thermography	06
6	Repair of Composites Restitution and repair of composites: Selection of Repair method, Repair criteria, Generic repair designs, Matrix cracks, Delamination, Holes and Fiber fracture, Damage removal and surface preparation	06

Text Books:

1. M.Balasubramanian, “Composites materials processing” ,1st edition, CRC press 2013.
2. A.K. Kaw, “Mechanics of Composite Materials”, Taylor and Francis Group, ISBN: 9780815351481
3. Ajay Kapadia, “Non Destructive Testing of Composite Materials”, National Composites Network
4. R.B. Heslehurst, “Defects and Damage in Composite Materials and Structures”, CRC Press 2014.

References:

1. R.M. Jones, “Mechanics of Composite Materials”, 2nd Edition,Taylor and Francis, Inc,ISBN: 9781138571075
2. I.M. Daniel and O. Isai, “Engineering Mechanics of Composite Materials”, 2nd Edition 2005,Oxford University Press, ISBN: 9780195150971
3. D. Gay, S.V. Hoe, and S.W. Tsai, “Composite Materials: Design and Applications”, 3rd Edition 2014, CRC Press, ISBN: 978-1466584877
4. R.B. Heslehurst, “Defects and Damage in Composite Materials and Structures”, CRC Press 2014.
5. [M.M. Schwartz](#), “Composite Materials: Properties, Nondestructive Testing, and Repair”, Prentice Hall PTR (1997), ISBN: 9780133000474

Course Code	Course Name	Credits
MEDLO8052	Smart Materials	03

Objectives

1. To study the working principles of various smart materials.
2. To identify applicability of various smart materials as actuator and sensor.
3. To study advances in smart materials

Outcomes: Learner will be able to...

1. Classify and select different types of smart materials
2. Comprehend Important Concepts and principles of Smart Materials
3. synthesis, sensing and actuation of Piezoelectric Materials, Magneto strictive Materials, Shape Memory Alloys, Electroactive Polymers
4. synthesis, sensing and actuation of Ferrofluids and Magneto rheological Fluids, Soft Matter, Carbon Nanotubes and Carbon nanostructures, Thermoelectric Materials
5. Classify and select Smart Materials for Energy Applications: Materials used for energy storage
6. Classify and select Composite Materials, Nano Composite Materials

Module	Contents	Hours
1	Introduction to Smart Materials: Overview of the different types of Smart Materials, Smart materials used in structures, smart material for sensors, actuators controls, memory and energy storage and their inter-relationships, concept of High bandwidth- low strain generating materials (HBLS), and Low Bandwidth High Strain Generating Materials (LBHS), Nano Composite Materials	07
2	Important Concepts of Smart Materials: artificial skins, artificial muscles, biomimetic materials, materials with tuneable responses, non-linear properties, self-healing materials, adaptive structures, self-replicating materials/structures, self-assembly, inch worm devices, hysteresis, integrated sensing and actuation	08
3	Overview of the following materials with focus on synthesis, constitutive/governing relationships, strengths and weaknesses, and applications (both sensing and actuation etc) 1. Piezoelectric Materials 2. Magneto strictive Materials 3. Shape Memory Alloys 4. Electroactive Polymers	06
4	Overview of the following materials with focus on synthesis, strengths and weaknesses, and applications 1. Ferrofluids and Magneto rheological Fluids and applications in dampers 2. Soft Matter and its applications as smart skins, smart textiles etc 3. Carbon Nanotubes and Carbon nanostructures and its applications 4. Thermoelectric Materials and Peltier devices	06

5	Smart Materials for Energy Applications: Materials used for energy storage, Hydrogen Storage Materials, Energy harvesting, Energy scavenging from vibrations	06
6	Manufacturing techniques for smart materials: micromanufacturing, high resolution lithography, LIGA process, Generative manufacturing processes such as STL, SLS, SPB, BPM, LOM, SGC, FDM, BIS, BPM, Self-assembly process, Ion beam processes,	06

Assessment:

Internal Assessment for 20 marks: Consisting of Two Compulsory Class Tests.

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

References:

1. M.V. Gandhi and B.S. Thompson, "Smart Materials and Structures", Chapman & Hall, London; New York, 1992 (ISBN: 0412370107)
2. Mel Schwartz, "Encyclopedia of Smart Materials Vol. I and II", John Wiley & Sons
3. SenolUtku, "Theory of Adaptive Structures : Incorporating Intelligence into Engineered Products", CRC Press (1998), ISBN: 9780849374319
4. A.V. Srinivasan, "Smart Structures: Analysis and Design", Cambridge University Press,Cambridge; New York, 2001 (ISBN: 0521650267)
5. G. Gautschi, "Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers", Springer, Berlin; New York, 2002 (ISBN:3540422595)
7. K. Uchino, "Piezoelectric Actuators and Ultrasonic Motors", Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114)
8. G. Engdahl, "Handbook of Giant Magneto strictive Materials", Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X)
9. K. Otsuka and C.M. Wayman, "Shape Memory Materials", Cambridge University Press, Cambridge; New York, 1998 (ISBN: 052144487X)
10. Eric Udd, "Fibre Optic Sensors: An Introduction for Engineers and Scientists", John Wiley & Sons, New York, 1991 (ISBN: 0471830070)
11. André Preumont, "Vibration Control of Active Structures: An Introduction", 2nd Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002 (ISBN: 1402004966)
12. HojjatAdeli, "Control, Optimization, and Smart Structures: High-Performance Bridges and Buildings of the Future", John Wiley, New York, 1999 (ISBN: 047135094X)
13. T.T. Soong, "Passive Energy Dissipation Systems in Structural Engineering", Wiley, Chichester; New York, 1997 (ISBN: 0471968218)

14. V.K. Wadhawan, Smart Structures: Blurring the Distinction Between the Living and Non-living , Oxford University Press, Oxford (2007) ISBN: 9780199229178
15. H.T. Banks, R.C. Smith and Y Wang, “Smart Structures: Modelling, Estimation and Control”, Wiley, New York (1996)
16. Shape Memory Alloys, (ed) D.C. Lagoudas, Springer Science (2008)
17. S.K. Ghosh , “Self-healing Materials: Fundamentals, Design Strategies and Applications, Wiley-VCH Verlag GmbH and Co. (2009), ISBN: 978-3-527-31829-2
18. Kwang J Kim and Satoshi Tadokore, “Electroactive Polymers for Robotic Applications: Artificial Muscles and Sensors”, Springer-Verlag, London (2007) ISBN: 9781846283710
19. S Priya and D J Inman, “Energy Harvesting Technologies”, Springer-Verlag (2008) ISBN: 978-0-387-76463-4
20. Moriaki Wakaki, “Optical Materials and Applications”, CRC Press (2012) ISBN: 9781315221403
21. S.S. Ray and M Bousmina, “Polymer Nanocomposites and their Applications”, American Scientific Publishers (2008)

Course Code	Course Name	Credits
MEDO8053	Micro Electro Mechanical Systems (MEMS)	03

Objectives:

1. To realize the benefits and effects of scaling.
2. To understand properties and crystallography of Silicon
3. To learn the microfabrication techniques
4. To understand the principles and uses of micro systems

Outcomes:

After taking this course, learner should be able to:

1. Apply laws of scaling for development of a MEMS device
2. Understand the materials and their processing to make MEMS
3. Select and use microfabrication techniques for microsystems
4. Understand the development of micro sensors and actuators
5. Analyze microsystems technology for technical feasibility as well as practicality
6. Develop useful applications of MEMS.

Module	Contents	Hours
1	Introduction to MEMS Unique characteristics of MEMS, Microsystems Technology- An Overview, typical MEMS and Microsystem Products, Scaling effects - scaling laws in miniaturization- Application of MEMS	05
2	Material for MEMS and manufacturing Structure of silicon and other materials - Silicon wafer processing - Bulk micromachining and Surface micromachining, Wafer-bonding. Thin-film deposition, Lithography, wet etching and dry etching.	07
3	Micro-fabrication methods LIGA and other moulding techniques- Soft lithography and polymer processing- Thick-film processing; Low temperature co-fired ceramic processing.	06
4	MEMS components-micro sensors Micro sensors - Basic principles and working of micro sensors- Acoustic wave micro sensors- Bio-medical micro sensors- Bio-sensors- Chemical microsensors – Optical Sensors – Pressure micro sensors- Thermal micro sensors-acceleration micro sensors;	08
5	Micro-actuators Basic principles and working of micro actuators- Electrostatic micro actuators- Piezoelectric micro actuators- Thermal micro actuators- SMA micro actuators- Electromagnetic micro actuators, micro valves, micro pumps.	06
6	Case studies /research based on MEMS applications-impact of materials, processes and design, Actuation using Shape Memory Alloys, Medical device, micropumps	04

Text books:

1. MEMS and Microsystems Design and Manufacture by Tai-Ran Hsu, Tata McGraw-Hill Publishing Company Ltd.
2. Foundation of MEMS by Chang Liu, Pearson Education

References:

1. Fundamentals of Microfabrication and Nanotechnology, by Marc J. Madou, CRC Press, 2011, ISBN: 9780849331800
2. Micromachined Transducers Sourcebook, by Gregory Kovacs, WCB McGraw-Hill, Boston, 1998, ISBN: 9780071164627
3. Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes, by M.H. Bao, Elsevier, New York, 2000, ISBN: 978-0444505583
4. Microsystem Design, by Stephen D Senturia, Springer Publication, 2000, ISBN: 9780792372462.
5. Micro sensors - Principles and Applications, by Julian W. Gardner, John Wiley & Sons, Inc.1994, ISBN: 9780471941361.

Course Code	Course Name	Credits
MEDLO8061	Product Design and Development	03

Objectives:

1. To understand the basic concepts of engineering design and product design & development, focusing on the front-end processes.
2. To demonstrate an understanding of the overview of all the product design & development processes.
3. To demonstrate knowledge of concept generation and the selection of tools.
4. To study the applicability of product design & development in industrial applications.

Outcomes: Upon satisfactory completion of this course, the student will be able to:

1. Describe the process of product design & development.
2. Employ engineering, scientific, and mathematical principles to develop and execute a design project from a concept to a finished product.
3. Create 3D solid models of mechanical components using CAD software.
4. Demonstrate individual skills using selected manufacturing techniques such as rapid prototyping.
5. Fabricate an electromechanical assembly of a product from engineering drawings.
6. Work collaboratively in a team to complete a design project.
7. Effectively communicate the results of projects and other assignments both in a written and oral format.

Module	Details	Hours
01	Need for developing products, The importance of Engineering and Industrial design, The design process, Relevance of product lifecycle issues in design, Societal considerations in Engineering and Industrial Design, Generic product development process, Various phases of product development, Planning for products, Establishing markets - market segments - relevance of market research.	7
02	The design processes, Descriptive and prescriptive design models, Concept development & evaluation, Pugh's total design activity model, Concept generation and selection method, Embodiment design, Product architecture, and Steps in developing product architecture.	7
03	Identifying customer needs, Voice of Customer (VoC), Customer populations, Hierarchy of human needs, Need gathering methods, Establishing engineering characteristics, Competitive benchmarking, Quality Function Deployment (QFD), House of Quality (HoQ), Product design specification, Development of product design with specifications using QFD, Relevant case studies.	7
04	Creative thinking, Creativity and problem-solving methods, Creative thinking methods, Brainstorming technique, Gordon technique, Check listing technique, Synectic technique, Morphological Analysis, and Attribute Listing technique. Generating design concepts, Systematic methods of designing.	7

05	Industrial design, Basic forms & elements, Integrating basic forms & elements such as balance, rhythm, proportion, The golden rule of proportions, human factors, and design, User-friendly design, Design for serviceability, Design for environment.	7
06	Concept of Design for Manufacturing and Assembly (DFMA). Role of computers in product design and manufacturing process, Prototyping techniques such as Stereolithography (SLA), Selective laser sintering (SLS), Fused deposition Modelling (FDM), Laminated object manufacturing (LOM), 3-D printing, and Ballistic Particle Manufacturing (BPM).	7

Text Books:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development," 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.
2. Kevin Otto, Kristin Wood, "Product Design," Indian Reprint 2004, Pearson Education, ISBN 9788177588217.

Reference Books:

1. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction," 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7.
2. George E. Dieter, Linda C.Schmidt, "Engineering Design," 4th Edition, McGraw-Hill International Edition, 2009, ISBN 978-007-127189-9.
3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process," 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141.

Course Code	Course Name	Credits
MELO8062	Design for X	03

Objectives:

1. To acquaint the learners with the concept of designformanufacturing and assembly
2. To acquaint the learners with the concept ofdesignfor reliability and maintainability
3. To study the product development economics.

Outcomes: Upon successful completion of this course, the learner will be able to

1. Applydesignconcepts and guidelines formanufacturing and assembly.
2. Demonstrate the concept of value analysis and its relevance.
3. Understand the economics of product development
4. Applydesignconceptsforreliability and maintainability

Module	Contents	Hours
1.	DESIGNFORMANUFACTURE: General design principles for manufacturability-strength and mechanical factors, mechanisms selection, evaluation method, Processcapability-Feature tolerances-Geometritolerances-Assembly limits—Datum features-Tolerance stacks	05
2.	DESIGN FOR ASSEMBLY: Assembly processes-Handling and insertion process-Manual, automatic and robotic assembly-Cost of Assembly-Number of Parts-DFA guidelines	08
3.	VALUEENGINEERING: Introduction to Value Engineering and Value Analysis, Valuetypes-functional—operational— aesthetic, Value engineering in product design; Advantages, Applications in product design, Problem identification and selection, Analysis of functions, Anatomy of function. Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST), Case studies.	08
4.	PRODUCTDEVELOPMENTECONOMICS: Elements of Economics Analysis-Quantitative and qualitative analysis-Economic Analysis Process-Estimating magnitude and time of future cash inflows and outflows-	08

	Sensitivity analysis-Project trade-offs-Trade-offs rules-Limitation of quantitative analysis-Influence of qualitative factors on project success	
5.	CONCEPT OF RELIABILITY: Introduction: The study of Reliability and Maintainability, Concepts, Terms and Definitions, Applications, The Failure Distribution: The reliability Function, Mean Time to Failure, Hazard Rate Function, Bathtub Curve, Conditional Reliability	05
6.	MAINTAINABILITY: Analysis of down time, Repair Time Distribution, Stochastic Point Processes, Reliability under Preventive Maintenance, State-Dependent System with Repair, Design for Maintainability.	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

References:

1. Harry Peck, Designing for Manufacture, Pitman Publications, 1983.
2. George E Dieter, Engineering Design, McGraw-Hill International Editions, 2000
3. S.S. Iyer, Value Engineering, New Age International, 2000
4. Charles E. Ebeling, An Introduction to Reliability and Maintainability Engineering, TMH 2000.

Course Code	Course Name	Credits
MEDLO8063	Total Quality Management	03

Objectives:

1. To understand the importance of Quality Management and principles of TQM
2. To understand seven basic QC tools and advanced QM tools
3. To understand the concept of Statistical Quality Control
4. To understand the concept of Continuous Improvement and TQM implementation
5. To understand different Quality Systems and Quality Standards
6. To understand the future trends in TQM and TQM strategies

Outcomes: The students will be able to use the tools and techniques of TQM in the manufacturing and service sectors.

1. To apply QM and principles of TQM in organizational development process.
2. To apply the QC & QM tools in process improvement.
3. To apply SQC techniques to improve process quality.
4. To apply Six Sigma project in TQM Implementation
5. To apply QMS and Certification for Quality Accreditation
6. To apply the advanced tools for Quality Sustainability.

Module	Contents	Hours
1	Introduction to Quality Management : A) Definitions of Quality, product quality and service quality; the evolution of quality; need for Quality Management, Quality statements and Policy, Customer orientation & satisfaction, Customer complaints, customer retention; Supplier partnership, Supplier rating & selection, CSI, Costs of Quality, Prevention , appraisal and failure aspects , Use of COQ for improving quality and performance, Designing for quality, Quality of design, Quality of conformance. B) Basic concepts of TQM, TQM framework, Contributions of Deming, Juran and Crosby, Juran Trilogy , PDCA Cycle, Barriers to TQM; TQM principles; Strategic Quality Planning; Quality councils; employee involvement, motivation; Empowerment; Team and Teamwork; recognition and reward, performance appraisal.	08
2	QC Tools : A) Seven QC Tools: Check Sheet, Histogram, Pareto Chart, Fishbone Diagram, Run Charts, Scatter Diagram, Process Flow Chart. B) Seven QM Tools: Program Decision Process Chart, Tree Diagram, Affinity Diagram, Prioritization Matrix, etc. Bench Marking Types – Process, Product, Quality Improvement Tools: Why-Why Analysis, Root Cause Analysis, Poka Yoke (Mistake Proofing)	06

3	Statistical Quality Control: 100% Inspection versus Sampling Inspection, Reasons for SQC. A) Acceptance Sampling: Concept of Producer Risk and Consumers Risk. Operating Characteristics Curve. Sampling Plan – Single Sampling Plan versus Double Sampling Plan. Design Sampling Plan on the basis of MIL, ASQ Standards. B) Statistical Process Control: Variations – Concept, Causes – Random & Assignable, Difference – Process in Control versus Process is Capable, Control Charts, X-Bar, R, P and C Charts, Process Capability (Cp) & Process Capability Index (Cpk), Sigma Limits. Applications of Control Charts in Mass Production, Process Production.	06
4	A) Continuous Improvement: Quality Circles, Quality Function Development (QFD), Taguchi quality loss function, Parameter Design, Robust Design; TPM- concepts, 5S, Kaizen, FMEA- stages, Zero Defect. B) TQM Implementation: Manufacturing and Service sectors, Introduction to Six Sigma: Definition, Concept, Methodology. Six Sigma Approaches – Design for Six Sigma (DFSS) Approach & DMAIC Approach, Six Sigma Tools: Applications to manufacturing and service sector including IT, ITeS, and E Com.	08
5	Quality Management System & Certification: A) QMS: Elements and documentation, Quality auditing, Necessity for Certification & Certification Process, Benefits of Certification. Certifying Bodies & Accreditation Agencies, ISO 9000-2015 (5th Edition), Introduction to TS16949: Technical Specifications, QS9000, ISO14000- concepts, requirements and benefits. Case studies of TQM implementation in manufacturing and service sectors including IT and Environmental management systems- ISO 14000 Series Standards, Integration of ISO 14000 with ISO 9000. B) Quality Awards: Malcom Baldrige National Quality Award and Rajiv Gandhi National Quality award.	06
6	Future Trends in TQM : Strategic approach to leadership , Customer centric endeavors , Involvement & empowerment of all employees / stake holders , Decision making based on real time facts , Win-Win policy with suppliers , New paradigms of Green & sustainability , TQM beyond Manufacturing i.e. Healthcare, Education, Finance. Accountability through new tools and technologies, Quality Analytics.	06

Text Books:

1. Besterfield D.H. et al.: Total quality Management, 3rd Edition, Pearson Education Asia, 2006.
2. Janakiraman B. and Gopal R.K.: Total Quality Management, Prentice Hall India, 2006.
3. Poornima M. Charantimath: Total Quality Management, 2nd Edition, Pearson Education Asia, 2006.
4. N. Logothetis: Managing for Total Quality, 6th Edition, Prentice Hall of India Pvt. Ltd. 2003.
5. Suganthi L. and Samuel A.: Total Quality Management, Prentice Hall India, 2006.
6. Evans J.R. and Lindsay W.M.: The Management and Control of Quality, 8th Edition, 1st Indian Edition, Cengage Learning, 2012.

Reference Books:

1. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 6th Edition, South-Western (Thomson Learning), 2005.
2. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.

Course Code	Course Name	Credits
ILO8021	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to...

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	5
02	Initiating Projects: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	8
04	Planning Projects: Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6

05	5.1 Executing Projects: Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings 5.2 Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit 5.3 Project Contracting Project procurement management, contracting and outsourcing,	8
06	6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects 6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

REFERENCES:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

Course Code	Course Name	Credits
ILO 8022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to...

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	Overview of Indian Financial System: Characteristics, Components and Functions of Financial System. Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09

04	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Entrepreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to...

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs
- 4.

Module	Detailed Contents	Hrs
01	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	Indian Environment for Entrepreneurship: key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08

06	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Outcomes: Learner will be able to...

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	Introduction to HR • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues	5
02	Organizational Behaviour (OB) • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	Organizational Structure & Design • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.	6

	- Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. - Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
04	Human resource Planning - Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale - Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning - Training & Development: Identification of Training Needs, Training Methods	5
05	Emerging Trends in HR - Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment - Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation	6
06	HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries) Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to...

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to...

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	Introduction and Basic Research Concepts 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
03	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design	08

	f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	
05	Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	Outcome of Research 6.1 Preparation of the report on conclusion reached 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation	04

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to...

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08

06	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	07

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,

- 12.** Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
- 13.** N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
- 14.** Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
- 15.** Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press.

Course Code	Course Name	Credits
ILO 8028	Digital Business Management	03

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	Introduction to Digital Business- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	Overview of E-Commerce E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure	06

4	Managing E-Business -Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	E-Business Strategy -E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	Materializing e-business: From Idea to Realization -Business plan preparation Case Studies and presentations	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan

- 8.** E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
- 9.** Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
- 10.** Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to...

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Credits
MEL801	Product Design and Development	01

Objectives:

1. To familiarize concepts in PD&D for practical implementation
2. To acquaint with the applicability of PD&D in industrial applications

Outcomes: Learner will be able to...

1. Identify the need for developing products
2. Select suitable PD&D processes
3. apply the creativity & industrial design methods to design & develop the chosen product
4. Work collaboratively in a team to complete a PD&D project.
5. Effectively communicate the results of projects and other assignments both in a written and oral format.

Assignments:

Total 3 to 4 assignments have to be given.

Assignments III and IV are compulsory and shall be treated like mini-projects. Two more could be covered from the remaining as case studies.

I. Based on Module No. 1 and 2.

1. Select any one consumer product, such as
 - a) a mobile
 - b) a laptop
 - c) a pencil sharpener
 - d) a table and chair
 - e) a stool
 - f) a bicycle
 - g) a pen
 - h) a storage device of any household items
 - i) a cupboard etc..... anything

Assume that you want to go for re-development of any one of the products. How would you tackle by answering any 3 or 4 points that are given below? Q1. How do you identify the need for developing the product?

Q2. What are the changes that you would like to incorporate?

Q3. Would it be Engineering Design or Industrial design factors or both? Q4.

What are the generic PD&D processes that you would like to adopt? Q5. What are the methods that you would adopt for Market research?

Q6. If you would like to develop which design process you would like to adopt?

Q7. If you select descriptive design... then why? If you select prescriptive design... then why? Q8. What are the steps that you would like to adopt while developing the product?

II. Based on Module No. 3.

2. Select any one consumer product, such as

- a) a mobile
- b) a laptop
- c) a pencil sharpener
- d) a table and chair
- e) a stool
- f) a bicycle
- g) a pen
- h) a storage device of any household items
- i) a cupboard etc..... anything

Assume that you want to go for re-development of any one of the above products.

How would you tackle by answering any 3 or 4 points that are given below?

Q1. How do you identify the customer needs for developing the product?

Q2. How do you ascertain/select the attributes that are to be tackled?

Q3. Would you like to go for Engineering Design factors or Industrial design factors or both?

Q4. How do you develop a correlation matrix?

Q5. How do you “Construct House of Quality”?

Q6. What are the generic PD&D processes that you would like to adopt in re-designing it using House of quality?

Q7. What are the methods that you would adopt for Market acceptance? Q8.

How do you document the entire design process?

III. Based on Module No. 4.

3. Select any one consumer product, such as

- a) a mobile

- b) a laptop
- c) a pencil sharpener
- d) a table and chair
- e) a stool
- f) a bicycle
- g) a pen
- h) a storage device of any household items
- i) a cupboard etc.... anything

Assume that you want to go for re-development of any one of the above products.

How would you apply the creativity method to design the chosen product using any one creativity methods? Develop the product and document the entire process by answering some of the questions as shown in I or II.

IV. Based on Module No. 5.

4. Select any one consumer product, such as
 - a) a mobile
 - b) a laptop
 - c) a pencil sharpener
 - d) a table and chair
 - e) a stool
 - f) a bicycle
 - g) a pen
 - h) a storage device of any household items
 - i) a cupboard etc.... anything

Assume that you want to go for re-development of any one of the above products.

How would you apply the principles of Industrial Design methods to design the chosen product? Develop the product and document the entire process by answering some of the questions as shown in I or II.

V. Based on Module No. 6.

5. Select any one consumer product, such as
 - a) a mobile
 - b) a laptop

- c) a pencil sharpener
- d) a table and chair
- e) a stool
- f) a bicycle
- g) a pen
- h) a storage device of any household items
- i) a cupboard etc..... anything

Assume that you want to go for re-development of any one of the above products.

How would you apply the principles of DFMA to design the chosen product? Develop the exploded view of the product and document the entire process by answering some of the questions as shown in I or II.

The distribution of marks for term work shall be as follows:

Assignments/Case studies:10 marks. Mini

Project:10 marks.

Attendance: 05 Marks.

End Semester Practical/Oral examination

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:
 - a) Practical performance**15** marks
 - b) Oral**10** marks

Evaluation of practical examination to be done based on the practical performed.

Students work along with evaluation reports to be preserved till the next examination.

Text/Reference Books:

1. Baker, M. & Hart S. (2007), Product Strategy and Management, (2nd. Ed.) Edinburgh: Pearson Education.
2. Ulrich, K. & Eppinger, S. (2012), Product Design and Development. (5th. Ed.) Los Angeles: McGraw Hill Education.
3. Yousef Haik, T. M. M. Shahin (2010), Engineering Design Process, (2nd. Ed. Reprint), Cengage Learning, ISBN 0495668141.
4. Kevin Otto, Kristin Wood (2004), Product Design, (Indian Reprint), Pearson Education, ISBN 9788177588217.

Course Code	Course Name	Credits
MEL802	Laboratory based on IoT	01

Objectives:

1. To learn microcontroller programming using 8051 and Arduino Development Board.
2. To acquaint with interfacing of simple peripheral devices to a microcontroller.
3. To acquaint with exchange of data using wireless communication.
4. To familiarize with logging the data on cloud platform.

Outcomes: Learner will able to...

1. Develop simple applications using microcontrollers 8051 and Arduino.
2. Interface simple peripheral devices to a Microcontroller.
3. Use microcontroller based embedded platforms in IoT.
4. Use wireless peripherals for exchange of data.
5. Setup cloud platform and log sensor data.

List of Experiments:

1. Interfacing experiments using 8051 Trainer kit and interfacing modules
 - a. display (LCD/LED/Seven Segment)
 - b. Stepper / DC Motor
2. Introduction to Arduino platform and programming
3. Simple Applications using Arduino Development Board (Any two)
 - a. Simple LED Blinking using development board
 - b. Building IOT Smart Switch using IOT
 - c. Pulse Width Modulation
 - d. Analog to Digital / Digital to Analog Conversion
4. Interfacing Arduino with a Sensor (Any one): Temperature Sensor / PIR/ Ultrasonic sensor/ IR Sensor/ Flame Sensor/ MQ6 Sensor/ Humidity sensor/ Raindrop Sensor, magnetometers, cameras, accelerometers etc.
5. Interfacing Arduino with an Actuator (Any One): Motors / solenoids / Controllers etc.
6. Communication using Wireless Medium (Any One): WiFi / Bluetooth / Zigbee / RFID etc.
7. Setting up and Cloud Platform and logging Sensor Data on the platform.

Assessment:

Term Work

Term work shall consist of the experiments as mentioned above.

The distribution of marks for term work shall be as follows:

1. Laboratory work (Experiments): 20 marks
2. Attendance: 05 marks

End Semester Practical/Oral Examination:

Pair of Internal and External Examiner should conduct practical examination followed by Oral.

Course Code	Course Name	Credits
MEP801	Major Project II	12

Objectives::

The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification to successful completion of the project by implementing the solution.

Outcomes: Learner will able to

- 1 Students will be able to implement solutions for the selected problem by applying technical and professional skills.
- 2 Students will be able to analyze impact of solutions in societal and environmental context for sustainable development.
- 3 Students will be able to collaborate best practices along with effective use of modern tools.
- 4 Students will be able to develop proficiency in oral and written communication with effective leadership and teamwork.
- 5 Students will be able to nurture professional and ethical behavior.
- 6 Students will be able to gain expertise that helps in building lifelong learning experience.

Guidelines:

1. Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.

2. Project Report Format:

At the end of semester, each group need to prepare a project report as per the guidelines issued by the University of Mumbai. Report should be submitted in hardcopy. Also, each group should submit softcopy of the report along with project documentation, implementation code, required utilities, software and user Manuals.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey/ Existing system
- Limitation Existing system or research gap
- Problem Statement and Objective

- Proposed System
 - Analysis/Framework/ Algorithm
 - Design details
 - Methodology (your approach to solve the problem) Proposed System
- Experimental Set up
 - Details of Database or details about input to systems or selected data
 - Performance Evaluation Parameters (for Validation)
 - Software and Hardware Set up
- Results and Discussion
- Conclusion and Future Work
- References
- Appendix – List of Publications or certificates

Desirable

- Students should be encouraged
 - to participate in various project competition.
 - to write minimum one technical paper & publish in good journal.
 - to participate in national / international conference.

3. Term Work:

Distribution of marks for term work shall be done based on following:

- a. Weekly Log Report
- b. Completeness of the project and Project Work Contribution
- c. Project Report (Black Book) (both side print)
- d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. Oral & Practical:

Oral & Practical examination (Final Project Evaluation) of Project 2 should be conducted by Internal and External examiners approved by University of Mumbai at the end of the semester.

Suggested quality evaluation parameters are as following:

1. Relevance to the specialization / industrial trends
2. Modern tools used
3. Innovation
4. Quality of work and completeness of the project
5. Validation of results
6. Impact and business value
7. Quality of written and oral presentation
8. Individual as well as team work

Proposed First Year Engineering Curriculum (Semester I & II)

and

Induction Program

(Common for All Branches of Engineering)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that in the present system, the first year syllabus is heavily loaded and it is of utmost importance that the students entering into the first year of an engineering course should feel at ease by lowering the burden of syllabus and credits. This is necessary for a student to get accustomed to the new environment of a college and to create a bonding between the teacher and a student. In this regard, AICTE has provided a model of Induction Program, which has been accommodated with certain modification and also overall credits proposed by AICTE in their model curriculum.

The present curriculum will be implemented for First Year of Engineering from the academic year 2019-20. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2020-21, for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande

Dean,

Faculty of Science and Technology,

Member - Academic Council

University of Mumbai, Mumbai

Structure for

Student Induction Program

New students enter an institution with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose.

The Induction Program is designed to make the newly joined students feel comfortable, sensitize them towards exploring their academic interests and activities, reducing competition and making them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and building of character.

Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

Transition from school to university/college life is one of the most challenging events in student's life. Therefore, it should be taken seriously, and as something more than the mere orientation program.

The time during the Induction Program is also used to rectify some critical lacunas, for example, English background, for those students who have deficiency in it.

New students be informed that the Induction is mandatory non-credit course for which a certificate will be issued by the institution.

At the start of the induction, the incumbents learn about the institutional policies, processes, practices, culture and values, and their mentor groups are formed. The different activities are:

1. **Orientation:** In the first session of Induction program learners and parents to be oriented about institute policies, processes, practices, culture and values. In addition to this, learners will be educated for 1st year academic program information in terms of academic calendar, Assessment plan, grading information, university ordinances, rules and regulations related to academics.
2. **Mentoring:** Mentoring and connecting the students with faculty members is the most important part of student induction. Mentoring process shall be carried out in small groups, group of 10 students to be formed and allocate one senior student from 3rd year of same program in which new students have taken admission, students mentor will continue for two years, till student mentors graduate from the institute. For two (2) such groups one faculty mentor to be allocated from the same department/program, who will remain the mentor till those students graduates from the institute. In the second session of Induction program, groups for mentoring to be formed and student mentors and faculty mentors to be introduced to newly inducted students. Introduction of mentoring system to be given to new students. Minimum one meeting to be conducted every month during semesters with students group by faculty mentors. For record keeping appropriate formats to be developed and information to be updated regularly by faculty mentors.

3. **Universal Human Values:** Universal Human Values gets the student to explore oneself and experience the joy of learning, prepares one to stand up to peer pressure and take decisions with courage, be aware of relationships and be sensitive to others, understand the role of money in life and experience the feeling of prosperity. Need for character building has been underlined by many thinkers, universal human values provide the base. Methodology of teaching this content is extremely important. It must not be through do's and don't's, but by getting the students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is essential for giving exposure, guiding thoughts, and realizing values.
4. **Proficiency Modules:** The induction program period can be used to overcome some critical lacunas that students might have, for example, English, Mathematics, computer familiarity etc. These should run like crash courses, so that when normal courses start after the induction program, the student has overcome the lacunas substantially.

A diagnostic test should be conducted on Day 2 itself. Before the test, the students should be informed that the test would not affect their grades, branch change, or any aspect of their admission, placement, study, etc. Purpose of the test is to provide help to those students who need help in English, Mathematics, Computer proficiency etc. Students having more than 80% marks in their qualifying examination in respective subjects need not take the diagnostic test. For those below this cut-off, writing the test is mandatory. Students with weak performance in the test, must attend a non-credit course in Basic English, Basic Mathematics, and Basic Computer Operation etc. Their attending the course is mandatory. There would be no separate fee payable for the course. The classes of Basic courses must start from Day 4 at the latest. Students those who are excluded from basic courses, for them some activity in the domain of creative arts, cultural and literature to be organised.

5. **Physical Activity:** Fitness session, yoga classes, lecture(s) on facing world with sportsman spirit, making young students aware that there is nothing like being failure in the world. The world gives opportunities to all.

The incoming students must be divided into batches of 50 students maximum, and a qualified coach in physical education/ faculty member should be attached to each batch. The list of available games, sport, or physical activities should be announced in orientation program on Day 1. They should be asked to fill their choice with three preferences, and the game or sport be allotted to them as per their preference. The physical activity should start from Day 3 onwards, wherein the student learns and plays his assigned game during the induction program. It is also important that along with his assigned game the student also practises yoga.

6. **Creative Arts, Cultural and Literary Activity:** Qualified instructors for arts may be hired on contract basis and be paid honorarium as per norms of the institute. Daily 90 to 120 minute sessions may be arranged. The list of available art forms, such as vocal music, instrumental music, folk music, painting, sketching, dance, group dance, clay modelling, pottery, dramatics, etc. should be

announced. They should be asked to fill their choice with three preferences, and the art form be allotted to them as per their preference. There should be sufficient number of teachers for each art form. The ratio may be kept as 1 teacher for every 25 students.

A faculty member interested in literary activity should be assigned for organizing the activity. A list of books which are interesting and educational should be prepared beforehand. Books in Indian languages must be included and even given priority. Students are losing connection with languages in general and their own language, in particular. Students should be assigned a book or other smaller reading material. They should be asked to read and write a critical summary. They should present their summary in front of their group. A literary group may consist of around 30-40 students. Similarly, debating and public speaking activity could also be undertaken. If the college can arrange for a drama workshop where a group of students learn and enact a play it would be very good. Not all the incoming students would do this, but those who wish may be provided the opportunity. Help may be taken from senior students engaged in such extra-curricular activities in the college.

7. **Familiarisation with Institute and Department:** The students admitted in a branch would visit their allotted department or branch. The Head of the department and other associated faculty should address the new student's right on Day 2 or so. Arrangements should be made about the meeting/gathering. The parents of the students should also be welcomed if they accompany their ward. It would be helpful if an alumnus of the Dept. relates his professional experience related to the field of the study to the incoming students.
8. **Lectures /Workshops by Eminent People:** Eminent people from all walks of life may be invited to deliver lectures, namely, from industry, academia, social science (authors, historians), social work, civil society, alumni etc. be identified and invited to come and address the new students. Motivational lectures about life, meditation, etc. by Ramakrishna Mission, Art of Living, S-VYASA university, Vivekanand Kendras, etc. may be organized. Workshops which rejuvenate or bring relief to students would also be welcome, such as, Art of Living workshops.
9. **Extra-Curricular Activity:** Every college has extra-curricular activities. Most of them are student driven. They are organized by student councils and clubs. The extra-curricular activities going on in the college should be presented to the new students under the guidance of faculty advisors for such activity. The new students should be informed about how they can join the activities. Related facilities should be described to them. Presentation on the activities by the student council should be made.
10. **Feedback and Report on the Program:** A formal feedback at the end of the program should be collected from students by their filling a form in writing or online. Besides the above, each group (of 20 students) should write a report on the Induction Program towards the end of the semester. They would also have to make a presentation of their report. They should be encouraged to use

slides while making a presentation. Presentation of the report should be made in the language they are comfortable with, without any insistence that it should be in English. It is more important that they feel comfortable and confident. Each group may make the presentation through 4-5 of its group members or more. In case, the number of new students in a college is large, the presentation should be made by each group in front of 4 other groups besides their own, thus there would be about 100 students (in 5 groups) in the audience in a session. Several such sessions could run in parallel or serially. In each session, their faculty mentors and student guides, if any, should also be in the audience. These sessions would tell you how well the program ran, and what the students are feeling at the end of the program. This would also serve as a grand closure to the program.

A certificate shall be awarded to all the students, upon successful completion of the induction program based on their report and presentation.

Tentative schedule of 1st Week Induction Program:

Day 1	Session 1	Orientation program
	Session 2	Mentoring (group formation and introduction)
Day 2	Session 3	Diagnostic test (basic English, maths and computer operation)
	Session 4	Familiarisation of Department and Institute (Visits to department, laboratory, Library, Examination cell, office etc)
Day 3	Session 5	Physical Activity (Yoga, sports etc)
	Session 6	Universal human values session
Day 4	Session 7	Proficiency Modules (Short courses on basic maths, English and computer operation etc. for identified students)
	Session 8	Physical Activity (Yoga, sports etc)
Day 5	Session 9	Proficiency Modules (Short courses on basic maths, English and computer operation etc. for identified students)
	Session 10	Creative Arts, Cultural and Literary Activity

A session may be conducted for around 2-3 hours each.

Minimum 12 sessions to be conducted from the following 20 sessions, from 2nd week to last week of academics, throughout the semester.

Session 11	Physical Activity (Yoga, sports etc)- 1
Session 12	Extra-Curricular Activity- 1
Session 13	Physical Activity (Yoga, sports etc)-2
Session 14	Extra-Curricular Activity- 2
Session 15	Physical Activity (Yoga, sports etc)- 3
Session 16	Lectures /Workshops by Eminent People- 1
Session 17	Physical Activity (Yoga, sports etc)- 4
Session 18	Lectures /Workshops by Eminent People- 2
Session 19	Creative Arts, Cultural and Literary Activity- 1
Session 20	Lectures /Workshops by Eminent People- 3
Session 21	Creative Arts, Cultural and Literary Activity- 2
Session 22	Universal Human Values- 1(Group Discussion among students as per mentoring group on various aspects of life, values, ethics etc.)
Session 23	Creative Arts, Cultural and Literary Activity- 3
Session 24	Universal Human Values- 2 (Group Discussion among students as per mentoring group on various aspects of life, values, ethics etc.)
Session 25	Creative Arts, Cultural and Literary Activity- 4
Session 26	Universal Human Values- 3 (Group Discussion among students as per mentoring group on various aspects of life, values, ethics etc.)
Session 27	Creative Arts, Cultural and Literary Activity- 5
Session 28	Physical Activity (Yoga, sports etc)- 5
Session 29	Feedback and Report on the Program- 1
Session 30	Feedback and Report on the Program- 2

Program Structure for First Year Engineering
Semester I & II
UNIVERSITY OF MUMBAI
(With Effect from 2019-2020)

Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
FEC101	Engineering Mathematics-I	3	--	1*	3	--	1	4	
FEC102	Engineering Physics-I	2		--	2		--	2	
FEC103	Engineering Chemistry-I	2	--	--	2	--	--	2	
FEC104	Engineering Mechanics	3	--	--	3	--	--	3	
FEC105	Basic Electrical Engineering	3	--	--	3	--	--	3	
FEL101	Engineering Physics-I	--	1	--	--	0.5	--	0.5	
FEL102	Engineering Chemistry-I	--	1	--	--	0.5	--	0.5	
FEL103	Engineering Mechanics	--	2	--	--	1	--	1	
FEL104	Basic Electrical Engineering	--	2	--	--	1	--	1	
FEL105	Basic Workshop practice-I	--	2	--	--	1	--	1	
Total		13	08	01	13	04	01	18	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC101	Engineering Mathematics-I	20	20	20	80	3	25	--	125
FEC102	Engineering Physics-I	15	15	15	60	2	--	--	75
FEC103	Engineering Chemistry-I	15	15	15	60	2	--	--	75
FEC104	Engineering Mechanics	20	20	20	80	3	--	--	100
FEC105	Basic Electrical Engineering	20	20	20	80	3	--	--	100
FEL101	Engineering Physics-I	--	--	--	--	--	25	--	25
FEL102	Engineering Chemistry-I	--	--	--	--	--	25	--	25
FEL103	Engineering Mechanics	--	--	--	--	--	25	25	50
FEL104	Basic Electrical Engineering	--	--	--	--	--	25	25	50
FEL105	Basic Workshop practice-I	--	--	--	--	--	50	--	50
Total		--	--	90	360	--	175	50	675

* May be conducted batch-wise

Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
FEC201	Engineering Mathematics-II	3	--	1*	3	--	1	4	
FEC202	Engineering Physics-II	2	--	--	2	--	--	2	
FEC203	Engineering Chemistry-II	2	--	--	2	--	--	2	
FEC204	Engineering Graphics	2	--	--	2	--	--	2	
FEC205	C programming	2	--	--	2	--	--	2	
FEC206	Professional Communication and Ethics- I	2	--	--	2	--	--	2	
FEL201	Engineering Physics-II	--	1	--	--	0.5	--	0.5	
FEL202	Engineering Chemistry-II	--	1	--	--	0.5	--	0.5	
FEL203	Engineering Graphics	--	4	--	--	2	--	2	
FEL204	C programming	--	2	--	--	1	--	1	
FEL205	Professional Communication and Ethics- I	--	2	--	--	1	--	1	
FEL206	Basic Workshop practice-II	--	2	--	--	1	--	1	
Total		13	12	01	13	06	01	20	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC201	Engineering Mathematics-II	20	20	20	80	3	25	--	125
FEC202	Engineering Physics-II	15	15	15	60	2	--	--	75
FEC203	Engineering Chemistry-II	15	15	15	60	2	--	--	75
FEC204	Engineering Graphics	15	15	15	60	3	--	--	75
FEC205	C programming	15	15	15	60	3	--	--	75
FEC206	Professional Communication and Ethics- I	10	10	10	40	2	--	--	50
FEL201	Engineering Physics-II	--	--	--	--	--	25	--	25
FEL202	Engineering Chemistry-II	--	--	--	--	--	25	--	25
FEL203	Engineering Graphics	--	--	--	--	--	25	50	75
FEL204	C programming	--	--	--	--	--	25	25	50
FEL205	Professional Communication and Ethics- I	--	--	--	--	--	25	--	25
FEL206	Basic Workshop practice-II	--	--	--	--	--	50	--	50
Total		--	--	90	360	--	200	75	725

* May be conducted batch-wise

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
FEC101	Engineering Mathematics-I	3	--	1*	3	--	1	4	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC101	Engineering Mathematics-I	20	20	20	80	3	25	--	125

Objectives

1. To develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.
2. To provide hands on experience using SCILAB software to handle real life problems.

Outcomes: Learner will be able to...

1. Illustrate the basic concepts of Complex numbers.
2. Apply the knowledge of complex numbers to solve problems in hyperbolic functions and logarithmic function.
3. Illustrate the basic principles of Partial differentiation.
4. Illustrate the knowledge of Maxima, Minima and Successive differentiation.
5. Apply principles of basic operations of matrices, rank and echelon form of matrices to solve simultaneous equations.
6. Illustrate SCILAB programming techniques to the solution of linear and simultaneous algebraic equations.

Module	Detailed Contents	Hrs.
01	Complex Numbers	
	Pre-requisite: Review of Complex Numbers-Algebra of Complex Number, Cartesian, polar and exponential form of complex number.	
	1.1. Statement of D'Moivre's Theorem.	2
	1.2. Expansion of $\sin n\theta$, $\cos n\theta$ in terms of sines and cosines of multiples of θ and Expansion of $\sin n\theta$, $\cos n\theta$ in powers of $\sin\theta$, $\cos\theta$	2
	1.3. Powers and Roots of complex number.	2
02	Hyperbolic function and Logarithm of Complex Numbers	
	2.1. Circular functions of complex number and Hyperbolic functions. Inverse Circular and Inverse Hyperbolic functions. Separation of real and imaginary parts of all types of Functions.	3
	2.2 Logarithmic functions, Separation of real and Imaginary parts of Logarithmic Functions.	3
	# Self learning topics: Applications of complex number in Signal processing, Electrical circuits.	
03	Partial Differentiation	
	3.1 Partial Differentiation: Function of several variables, Partial derivatives of first and higher order. Differentiation of composite function.	3
		3

	3.2.Euler's Theorem on Homogeneous functions with two independent variables (with proof). Deductions from Euler's Theorem. # Self learning topics: Total differentials, implicit functions, Euler's Theorem on Homogeneous functions with three independent variables.	
04	Applications of Partial Differentiation and Successive differentiation. 4.1 Maxima and Minima of a function of two independent variables, Lagrange's method of undetermined multipliers with one constraint. 4.2 Successive differentiation: nth derivative of standard functions. Leibnitz's Theorem (without proof) and problems # Self learning topics: Jacobian's of two and three independent variables (simple problems)	3 3
05	Matrices Pre-requisite: Inverse of a matrix, addition, multiplication and transpose of a matrix 5.1.Types of Matrices (symmetric, skew- symmetric, Hermitian, Skew Hermitian, Unitary, Orthogonal Matrices and properties of Matrices). Rank of a Matrix using Echelon forms, reduction to normal form and PAQ form. 5.2.System of homogeneous and non –homogeneous equations, their consistency and solutions. # Self learning topics: Application of inverse of a matrix to coding theory.	4 2
06	Numerical Solutions of Transcendental Equations and System of Linear Equations and Expansion of Function. 6.1 Solution of Transcendental Equations: Solution by Newton Raphson method and Regula –Falsi. 6.2 Solution of system of linear algebraic equations, by (1) Gauss Jacobi Iteration Method, (2) Gauss Seidal Iteration Method. 6.3 Taylor's Theorem (Statement only) and Taylor's series, Maclaurin's series (Statement only).Expansion of e^x , $\sin(x)$, $\cos(x)$, $\tan(x)$, $\sinh(x)$, $\cosh(x)$, $\tanh(x)$, $\log(1+x)$, (x) , (x) , (x) . # Self learning topics: Indeterminate forms, L- Hospital Rule, Gauss Elimination Method, Gauss Jordan Method.	2 2 2

Term Work

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write SCILAB Programs in tutorial class only. Each Student has to write at least 4 SCILAB tutorials (including print out) and at least 6 class tutorials on entire syllabus.
3. SCILAB Tutorials will be based on (i) Gauss Elimination Method (ii) Gauss Seidal Iteration method (iii) Gauss Jacobi Iteration Method (iv) Newton Raphson Method (v) Regula –Falsi method (vi) Maxima and Minima of functions of two variables

The distribution of marks for term work shall be as follows:

- Class Tutorials on entire syllabus : **10 marks**
- SCILAB Tutorials : **10 marks**
- Attendance (Theory and Tutorial) : **05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Assessment

Internal Assessment Test

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited, 9th Ed.
3. Engineering Mathematics by Srimanta Pal and Subodh, C. Bhunia, Oxford University Press
4. Matrices, Shanti Narayan, .S. Chand publication.
5. Applied Numerical Methods with MATLAB for Engineers and Scientists by Steven Chapra, McGraw Hill
6. Elementary Linear Algebra with Application by Howard Anton and Christ Rorres. 6th edition. John Wiley & Sons, INC.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC102	Applied Physics-I	2	-	-	2	-	-	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC102	Applied Physics-I	15	15	15	60	2	--	--	75

Objectives

1. To understand basic physics concepts and founding principles of technology.
2. To develop scientific temperament for scientific observations, recording, and inference drawing essential for technology studies.

Outcomes: Learner will be able to...

1. Illustrate the fundamentals of quantum mechanics and its application.
2. Illustrate the knowledge of crystal planes, X-ray diffraction and its application.
3. Illustrate the knowledge of Fermi level in semiconductors and applications of semiconductors in electronic devices.
4. Illustrate the knowledge of interference in thin films and its various applications.
5. Illustrate the basic knowledge of superconductors and supercapacitors.
6. Illustrate the knowledge of engineering materials and applications.

Module	Detailed Contents	Hrs.
01	QUANTUM PHYSICS (Prerequisites : Dual nature of radiation, Photoelectric effect Matter waves-wave nature of particles, de-Broglie relation, Davisson-Germer experiment) De Broglie hypothesis of matter waves; properties of matter waves; wave packet, phase velocity and group velocity; Wave function; Physical interpretation of wave function; Heisenberg uncertainty principle; non existence of electron in nucleus; Schrodinger's time dependent wave equation; time independent wave equation; Particle trapped in one dimensional infinite potential well, Quantum Computing.	07
02	SOLID STATE PHYSICS - CRYSTALLOGRAPHY (Prerequisites : Crystal Physics (Unit cell, Space lattice, Crystal structure, Simple Cubic, Body Centered Cubic, Face Centered Cubic, Diamond Structure, Production of X-rays) Miller indices; interplanar spacing; X-ray diffraction and Bragg's law; Determination of Crystal structure using Bragg's diffractometer;	03
03	SOLID STATE PHYSICS - SEMICONDUCTORS (Prerequisites: Intrinsic and extrinsic semiconductors, Energy bands in conductors, semiconductors and insulators, Semiconductor diode, I-V characteristics in forward and reverse bias) Direct & indirect band gap semiconductor; Fermi level; Fermi dirac distribution; Fermi energy level in intrinsic & extrinsic semiconductors; effect of impurity concentration and temperature on fermi level; mobility, current density; Hall	06

	Effect; Fermi Level diagram for p-n junction (unbiased, forward bias, reverse bias); Applications of semiconductors: LED, Zener diode, Photovoltaic cell.	
04	OPTICS-I (Prerequisites : Wave front and Huygen's principle, reflection and refraction, Interference by division of wave front, Youngs double slit experiment) Interference by division of amplitude, Interference in thin film of constant thickness due to reflected and transmitted light; origin of colours in thin film; Wedge shaped film; Newton's rings. Applications of interference - Determination of thickness of very thin wire or foil; determination of refractive index of liquid; wavelength of incident light; radius of curvature of lens; testing of surface flatness; Anti-reflecting films and Highly reflecting film.	06
05	SUPERCONDUCTORS AND SUPERCAPACITORS (Prerequisites : Electric current, flow of electric charges in a metallic conductor, drift velocity, mobility and their relation with electric current, Ohm's law, electrical resistance, V-I characteristics (linear and non-linear), electrical resistivity and conductivity temperature dependence of resistance) Superconductors: Critical temperature, critical magnetic field, Meissner's effect, Type I and Type II and high T _c superconductors; Supercapacitors: Principle, construction, types, materials and applications, comparison with capacitor and batteries : Energy density, Power density,	02
06	ENGINEERING MATERIALS AND APPLICATIONS (Prerequisites: Paramagnetic materials, diamagnetic materials, ferromagnetic materials, crystal physics, Conductors and insulators, free charges and bound charges inside a conductor. Dielectrics and electric polarisation, capacitors and capacitance) Liquid crystals: Nematic, Smectic and cholesteric phases, Liquid crystal display. Multiferroics : Type I & Type II multiferroics and applications, Magnetoresistive Oxides: Magnetoresistance, GMR and CMR materials, introduction to spintronics.	02

Assessment

Internal Assessment Test

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. A text book of Engineering Physics-Avadhanulu & Kshirsagar, S. Chand
2. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
3. Fundamentals of optics by Jenkins and White, McGrawHill
4. Solid State Electronic Devices- B. G. Streetman, Prentice Hall Publisher
5. Modern Engineering Physics – Vasudeva, S.Chand
6. Concepts of Modern Physics- Arther Beiser, Tata McGraw Hill
7. A text book of Engineering Physics-Avadhanulu & Kshirsagar, S. Chand
8. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
9. Fundamentals of optics by Jenkins and White, McGrawHill
10. Solid State Electronic Devices- B. G. Streetman, Prentice Hall Publisher
11. Modern Engineering Physics – Vasudeva, S.Chand
12. Concepts of Modern Physics- Arther Beiser, Tata McGraw Hill
13. A Text Book of Engineering Physics, S. O. Pillai, New Age International Publishers.
14. Introduction to Solid State Physics- C. Kittel, John Wiley& Sons publisher
15. Ultracapacitors: The future of energy storage- R.P Deshpande, McGraw Hill
16. Advanced functional materials – Ashutosh Tiwari, Lokman Uzun, Scrivener Publishing LLC.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC103	Applied Chemistry-I	02	-	-	02	-	-	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC103	Applied Chemistry-I	15	15	15	60	2	--	--	75

Objectives

1. The concepts developed in this course will aid in quantification as well as understand the applications of several concepts in Chemistry that have been introduced at the 10 + 2 levels in schools.

Outcomes: Learner will be able to...

1. Explain the concept of microscopic chemistry in terms of atomic and molecular orbital theory and relate it to diatomic molecules.
2. Describe the concept of aromaticity and interpret it with relation to specific aromatic systems.
3. Illustrate the knowledge of various types of intermolecular forces and relate it to real gases.
4. Interpret various phase transformations using thermodynamics.
5. Illustrate the knowledge of polymers, fabrication methods, conducting polymers in various industrial fields.
6. Analyze the quality of water and suggest suitable methods of treatment.

Module	Detailed Contents	Hrs.
01	Atomic and Molecular Structure Atomic orbitals (s,p,d,f) orbital shapes, Electronic Configuration, Molecular orbital theory (MOT), bonding and anti-bonding orbitals, Molecular orbital diagrams of Homonuclear and Heteronuclear diatomic molecules-Be ₂ , O ₂ , CO, NO their bond order and magnetic properties,	04
02	Aromatic systems & their molecular structure Define Aromaticity, Huckel's rule, Structure and bonding of benzene and pyrrole.	02
03	Intermolecular Forces & Critical Phenomena Ionic, dipolar and Vander Waal's interactions, Equations of state of real gases and critical phenomena	03
04	Phase Rule-Gibb's Phase Rule Statement of Gibbs' Phase Rule, Terms involved with examples, One Component System (Water), Reduced Phase Rule, Two Component System (Pb- Ag), Advantages and Limitations of Phase Rule. Numerical problems on Phase Rule.	05
05	Polymers Introduction: Definition- Polymer, polymerization, Properties of Polymers- Molecular weight (Number average and Weight average), Numerical problems on molecular weight, effect of heat on polymers (glass transition temperature), Viscoelasticity, Conducting Polymers, Classification-Thermoplastic and	05

	Thermosetting polymers; Compounding of plastic, Fabrication of plastic by Compression, Injection, Transfer and Extrusion moulding, Preparation, properties and uses of PMMA and Kevlar.	
06	Water Introduction - Impurities in water, hardness of water- units (no conversions), types and numerical problems, determination of hardness of water by EDTA method and numerical problems. Softening of water by Ion Exchange process and numerical problems, BOD, COD- definition, significance and Numerical problems. Water purification-membrane technology- Electrodialysis, Reverse osmosis, and Ultra filtration.	05

Assessment

Internal Assessment Test

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Engineering Chemistry - Jain & Jain (DhanpatRai)
2. Engineering Chemistry – Dara &Dara (S Chand)
3. Engineering Chemistry - Wiley India (ISBN – 9788126519880)
4. A Text Book of Engineering Chemistry – Shashi Chawla (DhanpatRai)
5. Engineering Chemistry – Payal Joshi & Shashank Deep (Oxford University Press)
6. Concise Inorganic Chemistry – J D LEE
7. Essentials of Physical Chemistry—B S Bahl Arun Bahl G D Tuli.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC104	Engineering Mechanics	3	--	--	3	--	--	3	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC104	Engineering Mechanics	20	20	20	80	3	--	--	100

Objectives

1. To familiarize the concept of equilibrium and friction
2. To study and analyze motion of moving particles/bodies.

Outcomes: Learner will be able to...

1. Illustrate the concept of force, moment and apply the same along with the concept of equilibrium in two and three dimensional systems with the help of FBD.
2. Demonstrate the understanding of Centroid and its significance and locate the same.
3. Correlate real life application to specific type of friction and estimate required force to overcome friction.
4. Establish relation between velocity and acceleration of a particle and analyze the motion by plotting the relation
5. Illustrate different types of motions and establish Kinematic relations for a rigid body
6. Analyze particles in motion using force and acceleration, work-energy and impulse-momentum principles

Self-Study/pre-requisites Topics:

Resolution of a forces. Use of trigonometry functions. Parallelogram law of forces. Law of triangle. Polygon law of forces, Lami's theorem. Concepts of Vector Algebra.

Uniformly accelerated motion along straight line, motion under gravity, projectile motion, Time of flight, Horizontal range, Maximum height of a projectile.

Law of conservation of Energy, Law of conservation of Momentum, Collision of Elastic Bodies.

Module	Detailed Contents	Hrs.
01	1.1 System of Coplanar Forces: Classification of force systems, Principle of transmissibility, composition and resolution of forces. 1.2 Resultant: Resultant of coplanar and Non Coplanar (Space Force) force system (Concurrent forces, parallel forces and non-concurrent Non-parallel system of forces). Moment of force about a point, Couples, Varignon's Theorem. Force couple system. Distributed Forces in plane.	06

02	Centroid: First moment of Area, Centroid of composite plane Laminas	03
03	3.1 Equilibrium of System of Coplanar Forces: Conditions of equilibrium for concurrent forces, parallel forces and non-concurrent non- parallel general forces and Couples. Equilibrium of rigid bodies-free body diagrams. 3.2 Equilibrium of Beams: Types of beams, simple and compound beams, type of supports and reaction: Determination of reactions at supports for various types of loads on beams. (Excluding problems on internal hinges)	04 03
04	Friction: Revision of Static Friction, Dynamic/ Kinetic Friction, Coefficient of Friction, Angle of Friction, Laws of friction. Concept of Cone of friction. Equilibrium of bodies on inclined plane. Application to problems involving wedges and ladders.	04
05	Kinematics of Particle: Motion of particle with variable acceleration. General curvilinear motion. Tangential & Normal component of acceleration, Motion curves (a-t, v-t, s-t curves). Application of concepts of projectile motion and related numerical.	04
06	Kinematics of Rigid Body: Translation, Rotation and General Plane motion of Rigid body. The concept of Instantaneous center of rotation (ICR) for the velocity. Location of ICR for 2 link mechanism. Velocity analysis of rigid body using ICR.	03
07	7.1 Kinetics of a Particle: Force and Acceleration: -Introduction to basic concepts, D'Alemberts Principle, concept of Inertia force, Equations of dynamic equilibrium, Newton's second law of motion. (Analysis limited to simple systems only.)	04
	7.2 Kinetics of a Particle: Work and Energy: Work Energy principle for a particle in motion. Application of Work – Energy principle to a system consists of connected masses and Springs.	04
	7.3 Kinetics of a Particle: Impulse and Momentum: Principle of linear impulse and momentum. Impact and collision: Law of conservation of momentum, Coefficient of Restitution. Direct Central Impact and Oblique Central Impact. Loss of Kinetic Energy in collision of inelastic bodies.	03

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. 10 percentage of marks will be asked from the self-study topics.
3. Total 04 questions need to be solved.
4. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
5. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
6. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

References:

1. Engineering Mechanics by R. C. Hibbeler.
2. Engineering Mechanics by Beer & Johnston, Tata McGraw Hill
3. Engineering Mechanics by F. L. Singer, Harper & Row Publication
4. Engineering Mechanics by Macklin & Nelson, Tata McGraw Hill
5. Engineering Mechanics by Shaum Series
6. Engineering Mechanics by A K Tayal, Umesh Publication.
7. Engineering Mechanics by Kumar, Tata McGraw Hill
8. Engineering Mechanics (Statics) by Meriam and Kraige, Wiley Books
9. Engineering Mechanics (Dynamics) by Meriam and Kraige, Wiley Books

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC105	Basic Electrical Engineering	3	--	--	3	--	--	3	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC105	Basic Electrical Engineering	20	20	20	80	3	--	--	100

Objectives

1. To provide knowledge on fundamentals of D.C. circuits and single phase and three phase AC circuits and its applications.
2. To inculcate knowledge on the basic operation and performance of 1- Φ transformer.
3. To provide knowledge on fundamentals of DC and AC machines.

Outcomes: Learner will be able to...

1. Apply various network theorems to determine the circuit response / behavior..
2. Evaluate and analyse 1- Φ circuits.
3. Evaluate and analyse 3- Φ AC circuits.
4. Understand the constructional features and operation of 1- Φ transformer.
5. Illustrate the working principle of 3- Φ machine.
6. Illustrate the working principle of 1- Φ machines.

Module	Detailed Contents	Hrs.
Prerequisite	Resistance, inductance, capacitance, series and parallel connections of resistance, concepts of voltage, current, power and energy and its units. Working of wattmeter, Magnetic circuits, MMF, Magnetic field strength, reluctance, series and parallel magnetic circuits, BH Curve, Time domain analysis of first order RL and RC circuits	--
01	DC Circuits: (Only independent source) Ideal and practical Voltage and current Sources, Source Transformation, Kirchhoff's Laws, Star-Delta / Delta-Star Transformations, Mesh and Nodal Analysis, Superposition, Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.	12
02	AC Circuits :Generation of alternating voltage, representation of sinusoidal alternating voltage and current, average and rms values, phase angle, phasor and phase difference, addition and subtraction of alternating quantities, Analysis of single-phase ac series and parallel circuits consisting of R, L, C, RL, RC, RLC combinations, real, reactive and apparent power, admittance (Y), Series and parallel resonance, Q factor	09
03	Generation of Three-Phase Voltages, Interconnection of three phases, voltage & current relationships in Star and Delta Connections, power measurement in three phase balanced circuit(Only two wattmeter method).	05

04	Transformers: Working principle of single-phase transformer, EMF equation of a transformer, Transformer losses, Actual (practical) and ideal transformer, Phasor diagram (considering winding resistance and magnetic leakage), Equivalent circuit, Open-circuit test (no-load test), short circuit (SC) test, regulation (no derivation), efficiency, condition for maximum efficiency, Working of Autotransformer	06
05	Electrical Machines (Numerical not expected): Rotating magnetic field produced by three phase ac, principle of operation of Three-phase induction motor, Concept of Slip, constructional details and classification of Induction machines.	02
06	Principle of operation of Single-Phase induction motors, stepper motor (Single stack variable reluctance and permanent magnet)	02
Self-study Topic	Principle of operation of DC generators and DC motors, constructional details and classification of DC machines, Applications of all DC Motors, emf equation of generator.	--

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

Text Books:

1. V. N. Mittal and Arvind Mittal “Basic Electrical Engineering” Tata McGraw Hill, (Revised Edition)
2. Vincent Del Toro “Electrical Engineering Fundamentals”, PHI Second edition, 2011
3. Edward Hughes “Hughes Electrical and Electronic Technology”, Pearson Education (Tenth edition)
4. D P Kothari and I J Nagrath “Theory and Problems of Basic Electrical Engineering”, PHI 13th edition 2011.
5. M. Naidu, S. Kamakshaiah “Introduction to Electrical Engineering” McGraw-Hill Education, 2004
6. B.R Patil “Basic Electrical Engineering” Oxford Higher Education

References:

1. B.L.Theraja “Electrical Engineering “ Vol-I and II.
2. S.N.Singh, “Basic Electrical Engineering” PHI , 2011Book

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL101	Applied Physics-I	-	01	-	-	-	0.5	0.5	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL101	Applied Physics-I	--	--	--	--	--	25	--	25

Objectives

1. To improve the knowledge about the theory learned in the class.
2. To improve ability to analyze experimental result and write laboratory report.

Outcomes: Learner will be able to...

1. Perform the experiments based on interference in thin films and analyze the results.
2. Verify the theory learned in the module crystallography.
3. Perform the experiments on various semiconductor devices and analyze their characteristics.
4. Perform simulation study on engineering materials.

Suggested Experiments: (Any five)

1. Determination of radius of curvature of a lens using Newton's ring set up
2. Determination of diameter of wire/hair or thickness of paper using Wedge shape film method.
3. Study of Miller Indices.
4. Study of Hall Effect.
5. Determination of energy band gap of semiconductor.
6. Study of Zener diode as voltage regulator.
7. Study of I/V characteristics of LED
8. Determination of 'h' using Photo cell.
9. Study of I / V characteristics of semiconductor diode
10. Charging and discharging characteristics of supercapacitor.
11. Simulation study of orientational ordering in Nematic like 2D liquid crystal.
12. Simulation experiments based on engineering materials using open source simulation softwares like Avogadro, Chimera, JMOL etc.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) : **10 marks**
- Project Groupwise (Topic Presentation) : **10 marks**
- Attendance (Theory and Tutorial) : **05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL102	Applied Chemistry-I	-	01	-	-	-	0.5	0.5	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL102	Applied Chemistry-I	--	--	--	--	--	25	--	25

Outcomes: Learner will be able to...

1. Determine Chloride content and hardness of water sample
2. Determine free acid pH of different solutions
3. Determine metal ion concentration
4. Synthesize polymers, biodegradable plastics.
5. Determine Viscosity of oil

Suggested Experiments:

1. To determine Chloride content of water by Mohr's Method.
2. To determine total, temporary and permanent hardness of water sample by EDTA method.
3. To determine free acid pH of different solutions using pH meter
4. To determine metal ion concentration using colorimeter.
5. Removal of hardness using ion exchange column.
6. Molecular weight determination of polymers by Oswald Viscometer.
7. Synthesis of UF, PF, Nylon 66.
8. Determination of COD
9. Synthesis of biodegradable polymer using corn starch or potato starch
10. Determination of Viscosity of oil by Redwood Viscometer

Term work:

Term Work shall consist of minimum five experiments.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) : **10 marks**
- Assignments and Viva on practicals : **10 marks**
- Attendance (Theory and Tutorial) : **05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL103	Engineering Mechanics	--	2	--	--	--	1	1	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL103	Engineering Mechanics	--	--	--	--	--	25	25	50

Objectives

1. To acquaint the concept of equilibrium in two and three dimensional system.
2. To study and analyse motion of moving particles/bodies.

Outcomes: Learner will be able to...

1. Verify equations of equilibrium of coplanar force system
2. Verify law of Moments.
3. Determine the centroid of plane lamina.
4. Evaluate co-efficient of friction between the different surfaces in contact.
5. Demonstrate the types of Collision/impact and determine corresponding coefficient of restitution.
6. Differentiate the Kinematics and Kinetics of a Particle.

List of Experiments:

Minimum six experiments from the following list of which minimum one should from dynamics.

1. Verification of Polygon law of coplanar forces
2. Verification of Principle of Moments (Bell crank lever.)
3. Determination of support reactions of a Simply Supported Beam.
4. Determination of coefficient of friction) using inclined plane
5. Verification of the equations of equilibrium for Non-concurrent non-parallel (General) force system.
6. Collision of elastic bodies (Law of conservation of momentum).
7. Kinematics of particles. (Uniform motion of a particle, Projectile motion, motion under gravity)
8. Kinetics of particles. (collision of bodies)

Sr No.	Assignments to be completed during Practical Session.	Minimum Number of Numerical
1	Resultant of Coplanar force system	4
2	Resultant of Non-Coplanar force system	3
3	Centroid of Composite plane Laminas	4
4	Equilibrium of System of Coplanar Forces	4
5	Beam Reaction	4
6	Equilibrium of bodies on inclined plane and problems involving wedges and ladders.	4
7	Kinematics of particles (Variable acceleration + Motion Curves +Projectile motion)	4
8	Kinetics of particles (D'Alemberts Principle, Work Energy Principle, Impulse momentum Principle, Impact and Collisions.)	5

Assessment:

Term Work: It comprises Laboratory Experiments and Assignments.

The distribution of marks for term work shall be as follows:

- Practical Work and Journal : 10 marks.
- Assignments : 10 marks.
- Attendance : 05 Marks

End Semester Examination:

Pair of Internal and External Examiner should conduct Oral examination based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL104	Basic Electrical Engineering	--	2	--	--	--	1	1	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL104	Basic Electrical Engineering	--	--	--	--	--	25	25	50

Objectives

1. To impart the basic concept of network analysis and its application.
2. To provide the basic concept of ac circuits analysis and its application.
3. To illustrate the operation of machines and transformer.

Outcomes: Learner will be able to...

1. Interpret and analyse the behaviour of DC circuits using network theorems.
2. Perform and infer experiment on single phase AC circuits.
3. Demonstrate experiment on three phase AC circuits.
4. Illustrate the performance of single phase transformer and machines.

Suggested List of laboratory experiments (Minimum Eight):

Also minimum two experiments from each course outcome shall be covered

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. To measure output voltage across load resistor/current through load resistor and verify the result using Mesh and Nodal analysis.
3. Verification of Superposition Theorem.
4. Verification Thevenin's Theorem.
5. Verification Norton's Theorem.
6. Verification Maximum Power Transfer Theorem.
7. To find the resistance and inductance of a coil connected in series with a pure resistance using three voltmeter method.
8. To find the resistance and inductance of a coil connected in parallel with a pure resistance using three ammeter method.
9. To find resonance conditions in a R-L-C series resonance circuit
10. To find resonance conditions in a R-L-C parallel resonance circuit.
11. To measure relationship between phase and line, currents and voltages in three phase system (star & delta)
12. To measure Power and phase in three phase system by two wattmeter method.
13. To find the equivalent circuit parameters by conducting OC and SC test on single phase transformer
14. To demonstrate cut-out sections of DC machine.
15. To demonstrate cut-out sections of single phase transformer.

Term Work: It comprises both part a and b

Term work consists of performing minimum 06 practical mentioned as below. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiment/journal) : 10 marks.
- Assignments : 10 marks.
- Attendance (Theory and Practical) : 05 Marks

End Semester Examination:

Pair of Internal and External Examiner should conduct Oral examination based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL105	Basic Workshop practice-I	--	2	--	--	--	1	1	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL105	Basic Workshop practice-I	--	--	--	--	--	50	--	50

Objectives

1. To impart training to help the students develop engineering skill sets.
2. To inculcate respect for physical work and hard labor.
3. To get exposure to interdisciplinary engineering domain.

Outcomes: Learner will be able to...

1. Develop the necessary skill required to handle/use different fitting tools.
2. Develop skill required for hardware maintenance.
3. Able to install an operating system and system drives.
4. Able to identify the network components and perform Basic networking and crimping.
5. Able to prepare the edges of jobs and do simple arc welding.
6. Develop the necessary skill required to handle/use different plumbing tools.
7. To demonstrate the turning operation with the help of a simple job.

	Detailed Content	Hrs.
	Note: Trade 1 and 2 are compulsory. Select any ONE trade topics out of the topic at trade 3 to 5. Demonstrations and hands on experience to be provided during the periods allotted for the same. Report on the demonstration including suitable sketches is also to be included in the term work CO-1 is related to Trade-1 CO-2 to CO-4 is related to Trade-2 CO-5 is related to Trade-3 CO-6 is related to Trade-4 CO-7 is related to Trade-5 CO evaluation is to be done according to the opted Trades in addition to Compulsory Trades.	
Trade-1	Fitting (Compulsory): • Use and setting of fitting tools for chipping, cutting, filing, marking, center punching, drilling, tapping. • Term work to include one job involving following operations : filing to size, one simple male- female joint, drilling and tapping	10

Trade-2	Hardware and Networking: (Compulsory) • Dismantling of a Personal Computer (PC), Identification of Components of a PC such as power supply, motherboard, processor, hard disk, memory (RAM, ROM), CMOS battery, CD drive, monitor, keyboard, mouse, printer, scanner, pen drives, disk drives etc. • Assembling of PC, Installation of Operating System (Any one) and Device drivers, Boot-up sequence. Installation of application software (at least one) • Basic troubleshooting and maintenance • Identification of network components: LAN card, wireless card, switch, hub, router, different types of network cables (straight cables, crossover cables, rollover cables) Basic networking and crimping. NOTE: Hands on experience to be given in a group of not more than four students	08
Trade-3	Welding: • Edge preparation for welding jobs. Arc welding for different job like, Lap welding of two plates, butt welding of plates with simple cover, arc welding to join plates at right angles.	06
Trade 4	Plumbing: • Use of plumbing tools, spanners, wrenches, threading dies, demonstration of preparation of a domestic line involving fixing of a water tap and use of coupling, elbow, tee, and union etc.	06
Trade-5	Machine Shop: • At least one turning job is to be demonstrated and simple job to be made for Term Work in a group of 4 students.	06

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC201	Engineering Mathematics-II	3	--	1*	3	1	--	4	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC201	Engineering Mathematics-II	20	20	20	80	3	25	--	125

Objectives

1. The course is aimed to develop the basic Mathematical skills of engineering students that are imperative for effective understanding of engineering subjects. The topics introduced will serve as basic tools for specialized studies in many fields of engineering and technology.
2. To provide hands on experience in using SCILAB software to handle real life problems

Outcomes: Learner will be able to...

1. Solve various types of First Order differential equation.
2. Solve various types of Higher Order Differential equation.
3. Illustrate the concepts of Beta and Gamma function, DUIS and rectification.
4. Apply the concepts of Double integral
5. Apply the concept of Triple integral.
6. Apply the principles of Numerical Method for solving differential equation and numerical integration analytically and using Scilab also.

Module	Detailed Contents	Hrs.
01	Differential Equations of First Order and First Degree	4
	1.1 Exact differential Equations, Equations reducible to exact form by using integrating factors.	2
	1.2 Linear differential equations (Review), equation reducible to linear form, Bernoulli's equation. # Self learning topics: Simple application of differential equation of first order and first degree to electrical and Mechanical Engineering problem	
02	Linear Differential Equations With Constant Coefficients and Variable Coefficients Of Higher Order	4
	2.1. Linear Differential Equation with constant coefficient- complementary function, particular integrals of differential equation of the type $f(D)y = X$ where X is e^{ax} , $\sin(ax + b)$, $(ax + b)$, $e^{ax}V$, xV .	2
	2.2. Method of variation of parameters. # Self learning topics: Cauchy's homogeneous linear differential equation and Legendre's differential equation, Applications of Higher order differential equation.	
03	Beta and Gamma Function, Differentiation under Integral sign and Rectification	
	Pre-requisite: Tracing of curves	
	1.1 Beta and Gamma functions and its properties.	2
	1.2 Differentiation under integral sign with constant limits of integration.	2
	1.3 Rectification of plane curves.(Cartesian and polar)	

	# Self learning topics: Rectification of curve in parametric co-ordinates.	2
04	Multiple Integration-1 4.1. Double integration-definition, Evaluation of Double Integrals.(Cartesian & Polar) 4.2. Evaluation of double integrals by changing the order of integration. 4.3. Evaluation of integrals over the given region. (Cartesian & Polar) # Self learning topics: Application of double integrals to compute Area, Mass.	2 2 2
05	Multiple Integration-2 5.1. Evaluation of double integrals by changing to polar coordinates. 5.2. Application of double integrals to compute Area 5.3. Triple integration definition and evaluation (Cartesian, cylindrical and spherical polar coordinates). # Self learning topics: Application of triple integral to compute volume.	2 2 2
06	Numerical solution of ordinary differential equations of first order and first degree, and , Numerical Integration 6.1. Numerical solution of ordinary differential equation using (a) Euler's method (b) Modified Euler method, (c) Runge-Kutta fourth order method 6.2. Numerical integration- by (a) Trapezoidal (b) Simpson's 1/3rd (c) Simpson's 3/8th rule (all with proof). # Self learning topics: Numerical solution of ordinary differential equation using Taylor series method.	3 3

Term Work

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write SCILAB Programs in tutorial class only. Each Student has to write at least 4 SCILAB tutorials (including print out) and at least 6 class tutorials on entire syllabus.
3. SCILAB Tutorials will be based on (i) Euler Method, (ii) Modified Euler Method, (iii) Runge-Kutta Method of fourth order , (iv) Trapezoidal Rule , (v) Simpson's 1/3rd Rule (vi) Simpson's 3/8th rule

The distribution of marks for term work shall be as follows:

- Class Tutorials on entire syllabus : **10 marks**
- SCILAB Tutorials : **10 marks**
- Attendance (Theory and Tutorial) : **05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Assessment

Internal Assessment Test

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus

3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited, 9th Ed.
3. Engineering Mathematics by Srimanta Pal and Subodh, C. Bhunia, Oxford University Press
4. Applied Numerical Methods with MATLAB for Engineers and Scientists by Steven Chapra, McGraw Hill
5. Elementary Linear Algebra with Application by Howard Anton and Christ Rorres. 6th edition. John Wiley & Sons, INC.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC202	Applied Physics-II	2	--	--	2	--	--	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC202	Applied Physics-II	15	15	15	60	2	--	--	75

Objectives

1. To give exposure to the topics of fundamental physics in the area of electrodynamics and relativity.
2. To give exposure to fundamentals of physics related with current technology in the field of Nanotechnology and Physics of Sensor Technology.

Outcomes: Learner will be able to...

1. Illustrate the knowledge of diffraction through slits and its applications.
2. Illustrate the working principle of various lasers and their applications in different fields, the concepts of optical fibre and its applications in communication system.
3. Illustrate the fundamentals of electrodynamics with required mathematical concepts.
4. Illustrate the fundamentals of relativity.
5. Illustrate the knowledge of synthesis, characterisation and applications of nanomaterials.
6. Illustrate the knowledge of working principles of various sensors.

Module	Detailed Contents	Hrs.
01	OPTICS-II (DIFFRACTION) (Prerequisites : Wave front and Huygen's principle, reflection and refraction, diffraction, Fresnel diffraction and Fraunhofer diffraction) Diffraction: Fraunhofer diffraction at single slit, Diffraction Grating, Resolving power of a grating; Applications of diffraction grating; Determination of wavelength of light using plane transmission grating	05
02	OPTICS-II (LASER AND FIBRE OPTICS) (Prerequisites: Absorption, recombination, energy bands of p-n junction, refractive index of a material, Snell's law) Laser: spontaneous emission and stimulated emission; metastable state, population inversion, types of pumping, resonant cavity, Einsteins's equations; Helium Neon laser; Nd:YAG laser; Semiconductor laser, Applications of laser- Holography Fibre optics: Numerical Aperture for step index fibre; critical angle; angle of acceptance; V number; number of modes of propagation; types of optical fibres; Fibre optic communication system;	07
03	ELECTRODYNAMICS (Prerequisites : Electric Charges, Coulomb's law-force between two point charges, Electric field, electric field due to a point charge, electric field lines, electric dipole, electric field due to a dipole, Gauss's law, Faraday's law) Scalar and Vector field, Physical significance of gradient, curl and divergence in Cartesian co-ordinate system, Gauss's law for electrostatics, Gauss's law for magnetostatics, Faraday's Law and Ampere's circuital law; Maxwell's equations (Free space and time varying fields).	03

04	RELATIVITY (Prerequisites: Cartesian co-ordinate system) Special theory of Relativity: Inertial and Non-inertial Frames of reference, Galilean transformations, Lorentz transformations (space – time coordinates & velocity only), Time Dilation, Length Contraction and Mass-Energy relation.	02
05	NANOTECHNOLOGY (Prerequisites : Scattering of electrons, Tunneling effect, Electrostatic focusing, magneto static focusing) Nanomaterials : Properties (Optical, electrical, magnetic, structural, mechanical) and applications, Surface to volume ratio; Two main approaches in nanotechnology -Bottom up technique and Top down technique; Tools for characterization of Nanoparticles: Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Atomic Force Microscope (AFM). Methods to synthesize Nanomaterials: Ball milling, Sputtering, Vapour deposition, Solgel	04
06	PHYSICS OF SENSORS (Prerequisites : Transducer concept, meaning of calibration, piezoelectric effect) Resistive sensors: a) Temperature measurement: PT100 construction, calibration, b) Thermocouples: concept, calibration, formulation and application of J - type and K-type thermocouple, c) Humidity measurement using resistive sensors, Pressure sensor: Concept of pressure sensing by capacitive, flex and inductive method, Analog pressure sensor: construction working and calibration and applications. Piezoelectric transducers: Concept of piezoelectricity, use of piezoelectric transducer as ultrasonic generator and application of ultrasonic transducer for distance measurement, liquid and air velocity measurement. Optical sensor: Photodiode, construction and use of photodiode as ambient light measurement and flux measurement. Pyroelectric sensors: Construction and working principle, application of pyroelectric sensor as bolometer.	05

Assessment

Internal Assessment Test

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. A text book of Engineering Physics-Avadhanulu & Kshirsagar, S.Chand
2. Optics - Ajay Ghatak, Tata Mc Graw Hill
3. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
4. Concepts of Modern Physics- Arther Beiser, Tata Mcgraw Hill
5. Introduction to Electrodynamics- D. J. Griffiths, Pearson publication
6. Introduction to Special Relativity- Robert Resnick, John Wiley and sons
7. Advances In Nano Materials And Applications: History of Nanotechnology From Pre-Historic to Modern Times, Madhuri Sharon, Wiley, USA
8. Nano: The essentials, understanding Nanoscience and Nanotechnology, T. Pradeep, Tata Mc Graw Hill, 2007.
9. Electronic Instrumentation –H.S. Kalsi, Tata Mc Graw-Hill Education
10. Handbook of Modern Sensors Physics design and application- Jacob Fraden, Springer, AIP press.
11. Instrumentation & Measurement Techniques by Albert D. Helfrick & William D. Cooper (PHI) Edition

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC203	Applied Chemistry-II	2	-	-	2	-	-	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC203	Applied Chemistry-II	15	15	15	60	2	--	--	75

Objectives

The concepts developed in this course will aid in quantification as well as understand the applications of several concepts in Chemistry that have been introduced at the 10 + 2 levels in schools.

Outcomes: Learner will be able to...

1. Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.
2. Illustrate the concept of emission spectroscopy and describe the phenomena of Fluorescence and Phosphorescence in relation to it.
3. Explain the concept of electrode potential and Nernst theory and relate it to electrochemical cells.
4. Identify different types of corrosion and suggest control measures in industries.
5. Illustrate the principles of green chemistry and study environmental impact.
6. Explain the knowledge of determining the quality of fuel and quantify the oxygen required for combustion of fuel.

Module	Detailed Contents	Hrs.
01	Principles of Spectroscopy: Introduction: Principle of spectroscopy, Definition, Origin of spectrum, Classification of spectroscopy – atomic and molecular, selection rules. Table of relation between electromagnetic spectrum, types of spectroscopy and energy changes.	02
02	Applications of Spectroscopy Emission spectroscopy- Principle, Instrumentation and applications (Flame Photometry) Introduction to florescence and phosphorescence, Jablonski diagram, application of fluorescence in medicine only.	04
03	Concept of Electrochemistry Introduction, concept of electrode potential, Nernst equation, types of electrochemical cells, concept of standard electrode with examples, electrochemical series, simple numericals.	02

04	Corrosion: Definition, Mechanism of Corrosion- (I) Dry or Chemical Corrosion-i) Due to oxygen ii) Due to other gases. (II) Wet or Electrochemical corrosion- Mechanism i) Evolution of hydrogen type ii) Absorption of oxygen. Types of Corrosion- Galvanic cell corrosion, Concentration cell corrosion (differential aeration principle), Pitting corrosion, Intergranular corrosion, Stress corrosion. Factors affecting the rate of corrosion- (i) Nature of metal, (ii) Nature of corroding environment. Methods of corrosion control- (I) Material selection and proper designing, (II) Cathodic protection- i) Sacrificial anodic protection ii) Impressed current method, (III) Metallic coatings- only Cathodic coating (tinning) and anodic coatings (Galvanising)	06
05	Green Chemistry and Synthesis of drugs Introduction – Definition, significance Twelve Principles of Green chemistry, numerical on atom economy, Conventional and green synthesis of Adipic acid, Indigo, Carbaryl, Ibuprofen, Benzimidazole, Benzyl alcohol, % atom economy and their numericals. Green fuel- Biodiesel.	04
06	Fuels and Combustion Definition, classification, characteristics of a good fuel, units of heat (no conversions). Calorific value- Definition, Gross or Higher calorific value & Net or lower calorific value, Dulong's formula & numerical for calculations of Gross and Net calorific values. Solid fuels- Analysis of coal- Proximate and Ultimate Analysis- numerical problems and significance. Liquid fuels- Petrol- Knocking, Octane number, Cetane number, Antiknocking agents, unleaded petrol, oxygenates (MTBE), catalytic converter. Combustion- Calculations for requirement of only oxygen and air (by weight and by volume only) for given solid & gaseous fuels.	06

Assessment

Internal Assessment Test

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

Recommended Books :

1. Engineering Chemistry - Jain & Jain, Dhanpat Rai
2. Engineering Chemistry – Dara & Dara, S Chand
3. Green Chemistry: A textbook – V.K.Ahluwalia, Alpha Science International
4. Fundamentals of Molecular Spectroscopy (4th Edition) - C.N.Banwell, Elaine M. McCash,
Tata McGraw Hill.
5. Elementary Organic Spectroscopy- Y.R.Sharma, S.Chand and Co.
6. A Text Book of Engineering Chemistry - Shashi Chawla, Dhanpat Rai
7. Engineering Chemistry – Payal Joshi & Shashank Deep (Oxford University Press)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC204	Engineering Graphics	2	--	--	2	--	--	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC204	Engineering Graphics	15	15	15	60	3	--	--	75

Objectives

1. To impart and inculcate proper understanding of the theory of projection.
2. To impart the knowledge of reading a drawing
3. To improve the visualization skill.

Outcomes: Learner will be able to...

1. Apply the basic principles of projections in Projection of Lines and Planes
2. Apply the basic principles of projections in Projection of Solids.
3. Apply the basic principles of sectional views in Section of solids.
4. Apply the basic principles of projections in converting 3D view to 2D drawing.
5. Read a given drawing.
6. Visualize an object from the given two views.

Module	Detailed Contents	Hrs.
01	Introduction to Engineering Graphics Principles of Engineering Graphics and their significance, usage of Drawing instruments, Types of Lines, Dimensioning Systems as per IS conventions. Introduction to plain and diagonal scales. Engineering Curves Basic construction of Cycloid, Involute and Helix (of cylinder) only.	2
02	Projection of Points and Lines Lines inclined to both the Reference Planes (Excluding Traces of lines) and simple application based problems on Projection of lines. @ Projection of Planes Triangular, Square, Rectangular, Pentagonal, Hexagonal and Circular planes inclined to either HP or VP only. (Exclude composite planes).	5
03	Projection of Solids (Prism, Pyramid, Cylinder, Cone only) Solid projection with the axis inclined to HP and VP. (Exclude Spheres, Composite, Hollow solids and frustum of solids). Use change of position or Auxiliary plane method	5
04	Section of Solids Section of Prism, Pyramid, Cylinder, & Cone cut by plane perpendicular to at least one reference plane (Exclude Curved Section Plane). Use change of position or Auxiliary plane method.	5

05	#Orthographic and Sectional Orthographic Projections: - Fundamentals of orthographic projections. Different views of a simple machine part as per the first angle projection method recommended by I.S. Full or Half Sectional views of the Simple Machine parts.	3
06	#@ Missing Views: The identification of missing views from the given views. Create the third view from the two available views so that all the details of the object are obtained.	1
07	#Isometric Views: - Principles of Isometric projection – Isometric Scale, Isometric Views, Conversion of Orthographic Views to Isometric Views(Excluding Sphere).	3
@ only in Term Work (i.e; Questions will not be asked for any examination.)		
# more problems should be discussed during practical hours to strengthen the concepts.		

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 15 marks each.

Among the two tests One is Conventional (manual drawing) and Second using CAD software.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 15 marks.
2. Any 4 questions need to be solved. There won't be any compulsory Question
3. Total 04 questions need to be solved.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

Text Books.

1. N.D. Bhatt, "Engineering Drawing (Plane and solid geometry)", Charotar Publishing House Pvt. Ltd.
2. N.D. Bhatt & V.M. Panchal, "Machine Drawing", Charotar Publishing House Pvt. Ltd.

Reference Books

3. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publisher.
4. Prof. Sham Tickoo (Purdue University) &GauravVerma, "(CAD Soft Technologies) : Auto CAD 2012 (For engineers and Designers)", Dreamtech Press NewDelhi.
5. Dhananjay A Jolhe, "Engineering Drawing" Tata McGraw Hill.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC205	Computer Programming in C	2	--	--	2	--	--	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC205	Computer Programming in C	15	15	15	60	3	--	--	75

Objectives

To provide exposure to problem-solving by developing an algorithm, flowchart and implement the logic using C programming language.

Outcomes: Learner will be able to...

1. To formulate simple algorithms for arithmetic, logical problems and translate them to programs in C language
2. To implement, test and execute programs comprising of control structures.
3. To decompose a problem into functions and synthesize a complete program.
4. Demonstrate the use of arrays, strings and structures in C language.
5. To understand the concept of pointers

Module	Detailed Contents	Hrs.
1	Introduction	5
	● Introduction to components of a Computer System ● Introduction to Algorithm and Flowchart	
	Fundamentals of C Programming	
	● Keywords, Identifiers, Constants and Variables ● Data types in C ● Operators in C ● Basic Input and Output Operations ● Expressions and Precedence of Operators ● In-built Functions	
2	Control Structures	7
	● Introduction to Control Structures	
	Branching and looping structures	
	● If statement, If-else statement, Nested if-else, else-if Ladder ● Switch statement ● For loop, While loop, Do while loop ● break and continue	
3	Functions	4
	● Introduction to functions ● Function prototype, Function definition, Accessing a function and parameter passing. ● Recursion.	

4	Arrays and Strings	4
	● Introduction to Arrays ● Declaration and initialization of one dimensional and two-dimensional arrays. ● Definition and initialization of String ● String functions	
5	Structure and Union	4
	● Concept of Structure and Union ● Declaration and Initialization of structure and union ● Nested structures ● Array of Structures ● Passing structure to functions	
6	Pointers	4
	● Fundamentals of pointers ● Declaration, initialization and dereferencing of pointers ● Operations on Pointers ● Concept of dynamic memory allocation	

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 15 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 15 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

Text Books:

1. E. Balaguruswamy, Programming in ANSI C, McGraw-Hill
2. Kernighan , Ritchie, “The C programming Language”, Prentice Hall of India
3. Sumitabha Das, Computer Fundamentals and C Programming, McGraw-Hill
4. Pradeep Day and Manas Gosh ,“Programming in C”, Oxford University Press.

References:

1. Byron Gottfried, “Programing with C”, Mc Graw Hill (Schaum”s outline series)
2. Venugopal K.R, Prasad Sudeep, “Mastering C”, McGraw-Hill
3. Kanetkar Yashwant,” “Let Us C”, BPB Publication.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEC206	Professional Communication and Ethics- I	2	--	--	2	--	--	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC206	Professional Communication and Ethics- I	10	10	10	40	--	--	--	50

Objectives

1. To demonstrate the fundamental concepts of interpersonal and professional communication.
2. To encourage active listening with focus on content, purpose, ideas and tone.
3. To facilitate fluent speaking skills in social, academic and professional situations.
4. To train in reading strategies for comprehending academic and business correspondence.
5. To promote effective writing skills in business, technology and academic arenas.
6. To inculcate confident personality traits along with grooming and social etiquettes.

Outcomes: Learners will be able to understand how to...

1. Eliminate barriers and use verbal/non-verbal cues at social and workplace situations.
2. Employ listening strategies to comprehend wide-ranging vocabulary, grammatical structures, tone and pronunciation.
3. Prepare effectively for speaking at social, academic and business situations.
4. Use reading strategies for faster comprehension, summarization and evaluation of texts.
5. Acquire effective writing skills for drafting academic, business and technical documents.
6. Successfully interact in all kinds of settings, displaying refined grooming and social skills.

Module	Detailed Contents	Hrs.
1	FUNDAMENTALS OF COMMUNICATION	12
	1.1. Introduction to Theory of Communication	
	● Definition ● Objectives ● Postulates/Hallmarks ● The Process of Communication ● Organizational Communication ○ Formal (Upward, Downward and Horizontal) ○ Informal (Grapevine)	
	1.2. Methods of Communication	
	● Verbal (Written & Spoken) ● Non-verbal ○ Non-verbal cues perceived through the five senses: (Visual, Auditory, Tactile, Olfactory and Gustatory cues) ○ Non-verbal cues transmitted through the use of: (The Body, Voice, Space, Time and Silence)	
	1.3. Barriers to Communication	
	● Mechanical/External ● Physical/Internal	

	● Semantic & Linguistic ● Psychological ● Socio-Cultural 1.4. Communication at the Workplace ● Corporate Communication - Case Studies ● Listening Tasks with Recordings and Activity Sheets ● Short Speeches as Monologues ○ Informative Speeches that Center on People, Events, Processes, Places, or Things ○ Persuasive Speeches to Persuade, Motivate or Take Action ○ Special Occasion Speeches for Ceremonial, Commemorative, or Epideictic purposes ● Pair-work Conversational Activities (Dialogues) ● Short Group Presentations on Business Plans	
2	VERBAL APTITUDE FOR EMPLOYMENT 2.1. Vocabulary Building ● Root words (Etymology) ● Meaning of Words in Context ● Synonyms & Antonyms ● Collocations ● Word Form Charts ● Prefixes & Suffixes ● Standard Abbreviations 2.2. Grammar ● Identifying Common Errors ○ Subject - Verb Agreement ○ Misplaced Modifiers ○ Articles ○ Prepositions ● Tautologies ● Pleonasms (Redundancies) ● Idioms ● Cliches	02
3	DEVELOPING READING AND WRITING SKILLS 3.1. Reading Comprehension ● Long Passages ● Short Passages ● MCQs on Inferential Questions with 4 Options 3.2. Summarization of reading passages, reports, chapters, books ● Graphic Organizers for Summaries ○ Radial Diagrams like Mind Maps ○ Flow Charts ○ Tree Diagrams ○ Cyclic Diagrams ○ Linear Diagrams like Timelines ○ Pyramids ○ Venn Diagrams ● Point-form Summaries ● One-sentence Summaries of Central Idea 3.3. Paraphrasing ● Understanding Copyrights ● Running a Plagiarism Check on Paraphrased Passages ● Generating Plagiarism Reports ● Basic APA and MLA Referencing Style and Format	02

4	BUSINESS CORRESPONDENCE 4.1. Seven Cs of Business Correspondence • Completeness • Conciseness • Consideration • Concreteness • Clarity • Courtesy • Correctness 4.2. Parts of a Formal Letter and Formats • Parts/Elements of a Formal Letter ○ Letterheads and/or Sender's Address ○ Dateline ○ Inside Address ○ Reference Line (Optional) ○ Attention Line (Optional) ○ Salutation ○ Subject Line ○ Body ○ Complimentary Close ○ Signature Block ○ Enclosures/Attachments • Complete/Full Block Format 4.3. Emails • Format of Emails • Features of Effective Emails • Language and style of Emails 4.4. Types of Letters in Both Formal Letter Format and Emails • Claim & Adjustment Letters • Request/Permission Letters • Sales Letters	06
	BASIC TECHNICAL WRITING 5.1. Introduction • What is Technical Writing? • Importance and Principles of Technical Writing • Difference between Technical Writing & Literary Writing • Framing Definitions • Difference between Technical Description & Instructions 5.2. Description of a Technical Object • Definition • Diagram • Discussion of Parts/Characteristics Working 5.3. Writing User Instructions • User Instructions • Special Notices (Note, Warning, Caution and Danger) • Styles of Presentation ○ Impersonal ○ Indirect ○ Direct • Imperative 5.4. Description of a Technical / Scientific Process • Definition • Diagram • Tools/ Apparatus/Software/ Hardware Used • Working	
5		02

	Result	
	PERSONALITY DEVELOPMENT AND SOCIAL ETIQUETTES	
6	6.1. Personality Development - Introducing Self and/or a Classmate - Formal Dress Code 6.2. Social Etiquettes - Formal Dining Etiquettes - Cubicle Etiquettes - Responsibility in Using Social Media - Showing Empathy and Respect - Learning Accountability and Accepting Criticism - Demonstrating Flexibility and Cooperation - Selecting Effective Communication Channels	02

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 10 marks each.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 15 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
4. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus
6. The first module (Fundamentals of Communication) will carry 40 % weightage.

Text Books.

1. Hemphill, P.D., McCormick, D. W., & Hemphill, R. D. (2001). Business Communication with writing improvement exercises. Upper Saddle River, NJ: Prentice Hall.
2. Locker, Kitty O. Kaczmarek, Stephen Kyo. (2019). Business Communication: Building Critical Skills. Place of publication not identified: Mcgraw-hill.
3. Murphy, H. (1999). Effective Business Communication. Place of publication not identified: Mcgraw-Hill.
4. Raman, M., & Sharma, S. (2016). Technical Communication: Principles and practice. New Delhi: Oxford University Press.
5. Kaul, A. (2015). Effective Business Communication. Place of publication not identified: Prentice-Hall of India.
6. Rizvi, A. M. (2010). Effective Technical Communication: A guide for Scientists and Engineers. New Delhi: Tata McGraw Hill.
7. Lewis, N. (2014). Word power made easy. Random House USA.
8. Sanjay Kumar & Pushp Lata (2018). Communication Skills with CD. New Delhi: Oxford University Press.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL201	Applied Physics-II	-	01	-	-	-	0.5	0.5	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL201	Applied Physics-II	--	--	--	--	--	25	--	25

Objectives

1. To improve the knowledge about the theory learned in the class.
2. To improve ability to analyze experimental result and write laboratory report.

Outcomes: Learner will be able to...

1. Perform the experiments based on diffraction through slits using Laser source and analyze the results.
2. Perform the experiments using optical fibre to measure numerical aperture of a given fibre.
3. Perform the experiments on various sensors and analyze the result.

Suggested Experiments: (Any five)

1. Determination of wavelength using Diffraction grating. (Hg/Na source)
2. Determination of number of lines on the grating surface using LASER Source.
3. Determination of Numerical Aperture of an optical fibre.
4. Determination of wavelength using Diffraction grating.(Laser source)
5. Study of divergence of laser beam
6. Determination of width of a slit using single slit diffraction experiment(laser source)
7. Study of I-V characteristics of Photo diode.
8. Study of ultrasonic distance meter/ interferometer.
9. Study of PT100 calibration and use and thermometer
10. Study of J /K type thermocouple, calibration and use and thermometer
11. Simulation experiments based on nanotechnology using open source simulation softwares like Avogadro, Chimera, JMOL etc.

Term work:

Term Work shall consist of minimum five experiments.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) : **10 marks**
- Project Groupwise (Execution & Submission) : **10 marks**
- Attendance (Theory and Tutorial) : **05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL202	Applied Chemistry-I	-	01	-	-	-	0.5	0.5	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL202	Applied Chemistry-I	--	--	--	--	--	25	--	25

Outcomes: Learner will be able to...

1. Determine moisture and ash content of coal
2. Analyze flue gas
3. Determine Saponification and acid value of oil
4. Determine flash point of a lubricating oil
5. Synthesize a drug and a biofuel.
6. Determine Na/K and emf of Cu-Zn system

Suggested Experiments

1. Determination of Moisture content of coal.
2. Determination of Ash content of coal.
3. Flue gas analysis using Orsat's apparatus.
4. Saponification value of oil
5. Acid value of oil
6. Determination of Na/K by Flame photometry.
7. Preparation of Biodiesel from edible oil.
8. To estimate the emf of Cu-Zn system by Potentiometry.
9. Synthesis of Aspirin.
10. Determination of Flash point of a lubricant using Abel's apparatus

Term work:

Term Work shall consist of minimum five experiments.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments and Journal) : **10 marks**
- Assignments and Viva on practicals : **10 marks**
- Attendance (Theory and Practical) : **05 marks**

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL203	Engineering Graphics	-	04	-	-	-	2	2	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL203	Engineering Graphics	--	--	--	--	--	25	50	75

Objectives

1. To inculcate the skill of drawing with the basic concepts.
2. To Use AutoCAD for daily working process.
3. To teach basic utility of Computer Aided drafting (CAD) tool

Outcomes: Learner will be able to...

1. Apply the basic principles of projections in 2D drawings using a CAD software.
2. Create, Annotate, Edit and Plot drawings using basic AutoCAD commands and features.
3. Apply the concepts of layers to create drawing.
4. Apply basic AutoCAD skills to draw different views of a 3D object.
5. Apply basic AutoCAD skills to draw the isometric view from the given two views.

Component-1 (Use half Imperial Drawing Sheet)

	Activities to be completed in the Drawing Laboratory.	Hrs
	One Practice sheet on projection of solids(minimum 2 problems)	4
	# Term Sheet 1: Projection of Solids (3 Problems).	4
	One Practice sheet on Section of Solids. (minimum 2 problems) # Term Sheet 2: Section of solids. (3 problems).	6
	One practice sheet on Orthographic projection. (minimum 1 problem) # Term Sheet 3: Orthographic Projection (With section 1 problem, without section 1 problem).	6
	One practice sheet on Isometric drawing. (minimum 2 problems) # Term Sheet 4: Isometric Projection. (3 problems).	4
# Term sheets to be done in laboratory only and to be submitted as part of term work. <i>Note: Practice sheets to be done before starting the Term Sheets.</i>		

Component-2

Self-study problems/ Assignment: (In A3 size Sketch book, to be submitted as part of Term Work)

1. Engineering Curves. (2 problems)
2. Projection of Lines (2 problems)
3. Projection of planes (2 problems)
4. Projection of solids. (2 problems)
5. Section of solids (2 problems)
6. Orthographic Projection. (With section 1 problem, without section 1 problem).
7. Missing views. (1 problem)
8. Isometric Drawing. (2 problems)

<u>Computer Graphics:</u> Engineering Graphics Software - Orthographic Projections, Isometric Projections, Co-ordinate Systems, Multi-view Projection.		
	To be Taught in laboratory.	Hrs
Part-A	Overview of Computer Graphics Covering: Listing the computer technologies that impact on graphical communication, demonstrating knowledge of the theory of CAD software such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.	3
	Customization & CAD Drawing: Consisting of set up of the drawing page and the printer including scale settings, Setting up of units and drawing limits, ISO and ANSI standards for coordinate dimensioning.	3
	Annotations, layering & other Functions Covering: Applying dimensions to objects, applying annotations to drawings, Setting up and use of layers, layers to create drawings, Create, edit and use customized layers, Changing line lengths through modifying existing lines (extend/lengthen), Printing documents to paper using the print command, orthographic projection techniques, Drawing sectional views of objects (simple machine parts).	4
Part-B	* Activities to be completed in the CAD Laboratory. (All printouts to be the part of Term Work. Preferably, Use A3 size sheets for print out.) <u>Component-3</u>	
	1. Orthographic Projections (without section)- 1 problem	4
	2. Orthographic Projection (with section)- 1 problem	4
	3. Orthographic Reading – 1 problem	2
	4. Isometric Drawing – 3 problem.	4

Note: * Give practice sheet problems before going for Term Sheet problems.
Students are supposed to bring complete solution of problems before coming to CAD practical.

Term Work:

Component-1	:	7Marks
Component-2	:	6 Marks
Component-3	:	7 Marks
Attendance	:	5 Marks

Total Marks : 25 Marks

Note: Satisfactory submission of all 3 components is mandatory to full fill the Term.

Topic for the End Semester Practical Examination (Auto CAD) (2 hours/ 50 Marks.)

1. Isometric drawing. (1 problem) (20 Marks)
2. Orthographic Projection (With Section) (1 problem). (30 Marks)

Note:

1. **Printout of the answers have to be taken preferably in A3 size sheets and should be Assessed by External Examiner only.**
2. **Knowledge of Auto CAD software, concepts of Engineering Graphics related to specified problem and accuracy of drawing should be considered during evaluation.**

Text Books.

1. N.D. Bhatt, "Engineering Drawing (Plane and solid geometry)", Charotar Publishing House Pvt. Ltd.
2. N.D. Bhatt & V.M. Panchal, "Machine Drawing", Charotar Publishing House Pvt. Ltd.

Reference Books

1. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publisher.
2. Prof. Sham Tickoo (Purdue University) &GauravVerma, "(CAD Soft Technologies) : Auto CAD 2012 (For engineers and Designers)", Dreamtech Press NewDelhi.
3. Dhananjay A Jolhe, "Engineering Drawing" Tata McGraw Hill.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL204	C programming	--	2	--	--	--	1	1	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg					
FEL204	C programming	--	--	--	--	--	25	25	50

Lab Outcomes:

- To translate given algorithms to a program.
- To be able to correct syntax and logical errors.
- To be able to write iterative as well as recursive programs.
- To be able to represent data in arrays, strings and structures and manipulate them through a program.
- To be able to declare pointers and demonstrate call by reference concept.

Lab Description:

Weekly 2 hours of laboratory Programming Assignments on the following topics:

- Basic data types and I/O operations
- Branching Statements
- Loop Statements
- Arrays
- Strings
- Functions
- Recursion
- Structure and Union
- Pointers

Term Work:

Experiments (20 Programs) and Assignments (2 Assignments) should be completed by students on the given time duration

Experiments -----(15) Marks

Assignment -----(05) Marks

Attendance -----(05) Marks

Total -----(25) Marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

Practical and Oral :

Practical and oral Exam should be conducted for the Lab, on Computer Programming in C subject for given list of experiments.

Implementation -----(15) Marks

Oral -----(10) Marks

Total -----(25) Marks

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL205	Professional Communication and Ethics- I	--	2	--	--	--	1	1	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL205	Professional Communication and Ethics- I	--	--	--	--	--	25	--	25

Objectives

To provide practice...

1. in active listening with focus on content, purpose, main idea, tone and pronunciation.
2. in fluent speaking and presentation skills in social, academic and professional situations.
3. in faster reading skills for effective comprehension in a variety of texts.
4. in drafting effective written discourse in academics, business and technology.
5. in grooming and projecting impressive persona in all interactions.

Outcomes: Learner will be able to...

1. listen and comprehend all types of spoken discourse successfully.
2. speak fluently and make effective professional presentations.
3. read large quantities of text in a short time to comprehend, summarise and evaluate content.
4. draft precise business letters, academic essays and technical guidelines.
5. dress finely and conduct themselves with panache in social, academic and professional situations.

List of Assignments & Activities	Details of Assignments	Details of Activities	Hrs.
1.	Written record of listening activities	Listening practice tasks of 3 types (through audio recordings of (1) Monologues (2) Dialogues (3) Formal/Expert Talk or Lecture)	02
2.	Transcription of the public speech along with a plagiarism report	Practice public speech	02
3.	Transcription of the public speech along with a plagiarism report	Public speech (Internal Assessment - I)	02
4.	Written assignment on barriers and non-verbal communication	Role plays / case studies	02
5.	Summarization through graphic organisers (1. Text to graphic organizer 2. Graphic organizer to text)	NA	02

6.	Written record of reading activities	Advanced level reading comprehension with MCQs (similar in level and format to CAT, GRE and GMAT verbal sections)	02
7.	Aptitude test on vocabulary and grammar	Aptitude test on vocabulary and grammar (similar in level and format to CAT, GRE and GMAT verbal sections)	02
8.	2 types of letters in complete block format	NA	02
9.	Written assignment on technical writing (Exercises based on framing Definitions, Describing Technical Objects, Framing User Instructions and Describing Technical Processes)	NA	02
10.	Documentation on case studies / role plays on Module 6	Case studies / role plays	02

Assessment:

Internal Assessment

TEST I - Public speech on general topics (Maximum 5 mins. per student)

TEST II - Written test covering modules 1 - 6

The second test should be based on theory and application exercises as mentioned in the syllabus. (Note: Summarization should be a compulsory question in Test II and not in the End Semester Theory Examination.)

The distribution of marks for term work shall be as follows:

- Assignments : **10 marks**
- Internal Assessment - I and II (average) : **10 marks**
- Attendance (Theory and Practical) : **05 marks**

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total	
FEL206	Basic Workshop practice-II	--	2	--	--	--	1	1	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEL206	Basic Workshop practice-II	--	--	--	--	--	50	--	50

Objectives

1. To impart training to help the students develop engineering skill sets.
2. To inculcate respect for physical work and hard labor.
3. To get exposure to interdisciplinary engineering domain.

Outcomes: Learner will be able to...

1. Develop the necessary skill required to handle/use different carpentry tools.
2. Identify and understand the safe practices to adopt in Electrical environment.
3. Demonstrate the wiring practices for the connection of simple electrical load/ equipment.
4. Design, Fabricate and Assemble PCB.
5. Develop the necessary skill required to handle/use different Masons tools.
6. Develop the necessary skill required to use different sheet metal and brazing tools.
7. Able to demonstrate the operation, forging with the help of a simple job.

	Detailed Content	Hrs.
Note: Trade 1 and 2 are compulsory. Select any ONE trade topics out of the topic trade 3 to 5. Demonstrations and hands on experience to be provided during the periods allotted for the same. Report on the demonstration including suitable sketches is also to be included in the term work CO-1 is related to Trade-1 CO-2 to CO-4 is related to Trade-2 CO-5 is related to Trade-3 CO-6 is related to Trade-4 CO-7 is related to Trade-5 CO evaluation is to be done according to the opted Trades in addition to Compulsory Trades.		
Trade-1	Carpentry (Compulsory) • Use and setting of hand tools like hacksaws, jack planes, chisels and gauges for construction of various joints, wood tuning and modern wood turning methods. • Term work to include one carpentry job involving a joint and report on demonstration of a job involving wood turning	10

Trade-2	Basic Electrical work shop:(Compulsory): • Single phase and three phase wiring. Familiarization. of protection switchgears and their ratings (fuse, MCB, ELCB). Wiring standards, Electrical safety in the work place safe work practices. Protective equipment, measures and tools. • Layout drawing, layout transfer to PCB, etching and drilling and soldering technique	08
Trade-3	Masonry: • Use of masons tools like trowels, hammer, spirit level, square, plumb line and pins etc. demonstration of mortar making, single and one and half brick masonry , English and Flemish bonds, block masonry, pointing and plastering.	06
Trade 4	Sheet metal working and Brazing: • Use of sheet metal, working hand tools, cutting , bending , spot welding	06
Trade-5	Forging (Smithy): • At least one forging job to be demonstrated and a simple job to be made for Term Work in a group of 4 students.	06

UNIVERSITY OF MUMBAI



Bachelor of Engineering in

Civil Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year
2019–2020)

Item No: -125

AC- 23/7/2020

UNIVERSITY OF MUMBAI



Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	Second Year B.E. Civil Engineering
2	Eligibility for Admission	After Passing First Year Engineering as per the Ordinance 0.6242
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	Ordinance 0.6242
5	No. of Years / Semesters	8 semesters
6	Level	U.G.
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic Year	With effect from Academic Year: 2020-2021

Date

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

The engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program Outcomes (POs) are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education (OBE) in the process of curriculum development from Rev-2012 onwards and continued to enhance the curriculum further based on OBE in Rev-2016 and Rev-2019 “C” scheme.

As Chairman and Members of Board of Studies in Civil Engineering, University of Mumbai, we are happy to state here that, the Program Educational Objectives (PEOs) for Undergraduate Program were finalized in a brain storming sessions, which was attended by more than 40 members from different affiliated Institutes of the University, who are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The PEOs finalized for the undergraduate program in Civil Engineering are listed below;

1. To prepare the Learner with a sound foundation in mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To prepare the Learner for a successful career in Indian and Multinational Organisations and for excelling in post-graduate studies
4. To motivate learners for life-long learning
5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process

In addition to the above listed PEOs, every institute is encouraged to add a few (2-3) more PEOs suiting their institute vision and mission

Apart from the PEOs, for each course of the program, objectives and expected outcomes from a learner's point of view are also included in the curriculum to support the philosophy of OBE. We strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Board of Studies in Civil Engineering, University of Mumbai

1. Dr. S. K. Ukarande:	Chairman
2. Dr. K. K. Sangle:	Member
3. Dr. S. B. Charhate:	Member
4. Dr. A. R. Kambekar:	Member
5. Dr. R. B. Magar:	Member
6. Dr. Seema Jagtap:	Member

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)
Semester - III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	
CEC301	Engineering Mathematics-III	3	-	1	3	-	1	4
CEC302	Mechanics of Solids	4			4			4
CEC303	Engineering Geology	3			3			3
CEC304	Architectural Planning & Design of Buildings	2	-	-	2	-	-	2
CEC305	Fluid Mechanics- I	3	-	-	3	-	-	3
CEL301	Mechanics of Solids	-	2	-	-	1	-	1
CEL302	Engineering Geology	-	2	-	-	1	-	1
CEL303	Architectural Planning & Design of Buildings	-	2	-	-	1	-	1
CEL304	Fluid Mechanics- I	-	2	-	-	1	-	1
CEL305	Skill Based Lab Course-I		3		-	1.5		1.5
CEM301	Mini Project – 1 A	-	3 ^s	-	-	1.5	-	1.5
Total		15	14	1	15	7	1	23

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)-	Term Work	Prac. /Oral	Total
		Test I	Test II	Avg .					
CEC301	Engineering Mathematics-III	20	20	20	80	3	25	-	125
CEC302	Mechanics of Solids	20	20	20	80	3	-	-	100
CEC303	Engineering Geology	20	20	20	80	3	-	-	100
CEC304	Architectural Planning & Design of Buildings	20	20	20	80	3	-	-	100
CEC305	Fluid Mechanics- I	20	20	20	80	3	-	-	100
CEL301	Mechanics of Solids	-	-	-	-	-	25	25	50
CEL302	Engineering Geology	-	-	-	-	-	25	25	50
CEL303	Architectural Planning & Design of Buildings	-	-	-	-	-	25	25	50
CEL304	Fluid Mechanics- I	-	-	-	-	-	25	25	50
CEL305	Skill Based Lab Course-I	-	-	-	-	-	50	-	50
CEM301	Mini Project – 1 A	-	-	-	-	-	25	25	50
	Total			100	400	-	200	125	825

Semester – IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	
CEC401	Engineering Mathematics - IV	3	--	1	3	-	1	4
CEC402	Structural Analysis	4	--	-	4	-	-	4
CEC403	Surveying	3	--	-	3	-	-	3
CEC404	Building Materials & Concrete Technology	3	--	-	3	-	-	3
CEC405	Fluid Mechanics-II	3	-	-	3	-	-	3
CEL 401	Structural Analysis	--	2	-	-	1	-	1
CEL 402	Surveying	--	3	-	-	1.5	-	1.5
CEL 403	Building Material Concrete Technology	--	2	-	-	1	-	1
CEL 404	Fluid Mechanics-II	--	2	-	-	1	-	1
CEL 405	Skill Based lab Course-II	--	2	-	-	1	-	1
CEM401	Mini Project – 1 B	--	3 ^s	-	-	1.5	-	1.5
Total		16	14	1	16	7	1	24

Examination Scheme

Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)-	Term Work	Prac. /Oral	Total
		Test I	Test II	Avg .					
CEC 401	Engineering Mathematics - IV	20	20	20	80	3	25	-	125
CEC 402	Structural Analysis	20	20	20	80	3	-	-	100
CEC 403	Surveying	20	20	20	80	3	-	-	100
CEC 404	Building Materials & Concrete Technology	20	20	20	80	3	-	-	100
CEC 405	Fluid Mechanics-II	20	20	20	80	3	-	-	100
CEL 401	Structural Analysis						25	25	50
CEL 402	Surveying						50	25	75
CEL 403	Building Materials & Concrete Technology	-	-	-	-	-	25	25	50
CEL 404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL 405	Skill Based lab Course-II	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1 B	-	-	-	-	-	25	25	50
Total				100	400	-	225	125	850

Semester- III

Course Code	Course Name	Credits
CEC 301	Engineering Mathematics-III	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	01	03	-	01	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	25	-	-	125

Pre-requisite: Engineering Mathematics-I,
Engineering Mathematics-II,

Course Objectives:

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills.
3. To familiarize with the concept of complex variables, C-R equations with applications.
4. To study the application of the knowledge of matrices and numerical methods in complex engineering problems.

Course Outcomes: Learner will be able to....

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.
6. Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

Module	Detailed Contents	Hrs.
01	Module: Laplace Transform 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform, 1.2 Laplace Transform (L) of Standard Functions like e^{at} , $\sin(at)$, $\cos(at)$, $\sinh(at)$, $\cosh(at)$ and t^n , where $n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by t , Division by t , Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation. Self-learning topics: Heaviside's Unit Step function, Laplace Transform. of Periodic functions, Dirac Delta Function.	07 Hrs.
02	Module: Inverse Laplace Transform 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivative 2.2 Partial fractions method & first shift property to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) Self-learning Topics: Applications to solve initial and boundary value problems involving ordinary differential equations.	06 Hrs.
03	Module: Fourier Series: 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof) 3.2 Fourier series of periodic function with period 2π and $2l$, 3.3 Fourier series of even and odd functions 3.4 Half range Sine and Cosine Series. Self-learning Topics: Complex form of Fourier Series, orthogonal and orthonormal set of functions, Fourier Transform.	07Hrs.
04	Module: Complex Variables: 4.1 Function $f(z)$ of complex variable, limit, continuity and differentiability of $f(z)$, Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof), 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof) 4.3 Milne-Thomson method to determine analytic function $f(z)$ when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given.	07Hrs.

	4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories Self-learning Topics: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations	
05	Module: Matrices: 5.1 Characteristic equation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors. (No theorems/ proof) 5.2 Cayley-Hamilton theorem (without proof): Application to find the inverse of the given square matrix and to determine the given higher degree polynomial matrix. 5.3 Functions of square matrix 5.4 Similarity of matrices, Diagonalization of matrices Self-learning Topics: Verification of Cayley Hamilton theorem, Minimal polynomial and Derogatory matrix & Quadratic Forms (Congruent transformation & Orthogonal Reduction)	06 Hrs.
06	Module: Numerical methods for PDE 6.1 Introduction of Partial Differential equations, method of separation of variables, Vibrations of string, Analytical method for one dimensional heat and wave equations. (only problems) 6.2 Crank Nicholson method 6.3 Bender Schmidt method Self-learning Topics: Analytical methods of solving two and three dimensional problems.	06 Hrs.
	Total	39

Term Work:

General Instructions:

- 1 Batch wise tutorials are to be conducted. The number of student's per batch should be as per University pattern for practicals.
- 2 Students must be encouraged to write at least 6 class tutorials on entire syllabus.
- 3 A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4 Only Four questions need to be solved.

References:

- 1 Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
- 2 Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
- 3 Advanced Engineering Mathematics, R. K. Jain and S.R.K. Iyengar, Narosa publication
- 4 Advanced Engineering Mathematics, H.K. Das, S. Chand Publication
- 5 Higher Engineering Mathematics B.V. Ramana, McGraw Hill Education
- 6 Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education,
- 7 Text book of Matrices, Shanti Narayan and P K Mittal, S. Chand Publication
- 8 Laplace transforms, Murray R. Spiegel, Schaum's Outline Series

Semester- III								
Course Code			Course Name					Credits
CEC 302			Mechanics of Solids					4
Contact Hours				Credits Assigned				
Theory	Practical		Tutorial	Theory	Practical	Tutorial	Total	
4	-			4	-	--	4	
Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem Exam	TE	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	--	--	100

Rationale

Civil Engineering structures are made using various engineering materials such as steel, concrete, timber, other metals or their composites. They are subjected to force systems resulting into axial forces, bending moments, shear forces, torsion and their combinations. Different materials respond differently to these by getting deformed and having induced stresses. Determination of stress, strain, and deflection suffered by structural elements when subjected to diverse loads is prerequisite for an economical and safe design.

In this course, learners will understand the internal response behavior of material under different force systems. The knowledge of 'Mechanics of Solids' will be foundation of essential theoretical background for the subjects of Structural Analysis and Structural Design.

Objectives

- 1) To learn stress - strain behavior and physical properties of materials and to compute the Stresses developed and deformation of Elastic members and thin cylinders subjected to internal pressure.
- 2) To learn to represent graphically the distribution of axial force, shear force and bending moment along the length of statically determinate beams and portal frames.
- 3) To compute area moment of inertia and to analyze the distribution of shear stress and the flexural (bending) stress across the cross section of structural members.
- 4) To study circular shafts under the action of twisting moment and to determine the direct and bending stresses in columns and study buckling behavior of centrally and eccentrically loaded columns.
- 5) To determine principal planes and stresses and strain energy computation in elastic members.
- 6) To learn the computation of slope and deflection of elastic beams and general theorems used in this computation.

Detailed Syllabus			
Module		Course Modules / Contents	Periods
1	Module Name- Stresses and Strains in Elastic members, Spherical and Cylindrical shells		(9)
	1.1	Types of Stresses and Strains, stress-strain curve, different types of Elastic moduli and relationships between them, Poisson's ratio, factor of safety. Bars of varying sections, composite sections, temperature stresses	6
	1.2	Thin cylindrical and spherical shells under Internal pressure: Determination of Hoop stress, Longitudinal stress, Shear stress and volumetric strain.	3
2	Module Name- Axial force, shear force and bending moment diagrams for beams and portal frames		(9)
	2.1	Concept of Axial Force, Shear Force and Bending Moment. a) A.F. S.F. and B M Diagrams for statically determinate S S and Cantilever beams without internal hinges and for single loading like point load, UDL, UVL or Couple moment. b) A.F. S.F. and B.M. Diagrams for statically determinate beams with internal hinges and combination of loading	6
	2.2	A.F. S.F. and B.M Diagrams for statically determinate 3-member Portal Frames with or without internal hinges .	3
3	Module Name- Area Moment of Inertia, Shear stresses and Bending stresses in beams		(9)
	3.1	Area Moment of inertia, Parallel and Perpendicular axis theorem, polar moment of inertia. Radius of gyration. (Rectangular, Triangular, Circular, Semicircular section and their combination) Distribution of shear stress across plane sections Commonly used for structural purposes.	5
	3.2	Theory of pure bending, Flexure formula for straight beam, simple problems involving application of Flexure formula, section modulus, moment of resistance, flitch beams.	4
4	Module Name- Torsion in Shafts, Columns		(10)
	4.1	Torsion in solid and hollow circular shafts, shafts with varying cross sections, Shafts transmitting and receiving power at different points. Stresses in Shafts while transmitting power.	4
	4.2	Direct and bending stresses in Columns, Core of section.	6

		Buckling of Columns, Members subjected to axial loading, concept of buckling, effective length, different support conditions, Euler's and Rankine's formula. Concept of Eccentrically loaded columns.	
5	Module Name- Principal planes and stresses, Strain Energy		(8)
	5.1	General equation for transformation of stress, Principal planes and principal stresses, maximum Shear stress, stress determination by analytical and Graphical method (using Mohr's circle).	4
	5.2	Strain energy due to axial force and impact loads in columns, due to bending in beams, due to torsion of shaft.	4
6	Module Name- Slope and Deflection in Beams , General Theorems		(7)
	6.1	Concept of Slope and Deflection in Beams, Macaulay's Method for slope and deflection in S S and Cantilever beams subjected to point loads, UDL and couple moments.	4
	6.2	General Theorems: Betti and Maxwell's reciprocal Theorem,, Principle of Superposition, Principle of Virtual work, Castigliano's theorems.	3

Contribution to Outcome

On completion of this course, the students will be able to:

- 1) Evaluate stress - strain behavior of elastic members and thin cylinders subjected to internal pressure.
- 2) Draw variation of axial force, shear force and bending moment diagram for statically determinate beams and frames.
- 3) Calculate Moment of Inertia for cross sections and analyse the material response under the action of shear and the effect of flexure (bending).
- 4) Predict the angle of twist and shear stress developed in torsion and compute direct and bending stresses developed in the cross section of centrally and eccentrically loaded columns.
- 5) Locate principal planes in members and calculate principal stresses using analytical and graphical method and to calculate strain energy stored in members due to elastic deformation.
- 6) Evaluate slope and deflection of beams supported and loaded in different ways.

Internal Assessment (20 Marks):

One **Compulsory Class Test**, based on approximately 40% of contents and another on 40% from the remaining content be taken. Average of the two will be considered as IA Marks.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture

Hours mentioned in the curriculum.

- 1) Question paper will comprise of total **six questions, each carrying 20 marks.**
- 2) **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
- 3) **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4) Only **Four questions need to be solved.**

Recommended Books:

1. Strength of Materials: *S. Ramamrutham*, Dhanpatrai Publishers.
2. Strength of Materials: *R.K. Rajput*, S. Chand Publications.
3. Mechanics of Materials: Vol-I: *S.B. Junnarkar and H.J. Shah*, Charotar Publications.
4. Strength of Materials: *Subramanian*, Oxford University Press
5. Strength of Materials: *S.S. Rattan*, Tata Mc-Graw Hill, New Delhi
6. Strength of Materials (Mechanics of Materials): *R.S. Lehri and A.S. Lehri*, S.K. Kataria Publishers, New Delhi
7. Strength of Materials: *Dr. V.L. Shah*, Structures Publications, Pune

Reference Books:

8. Mechanics of Materials: *James, M. and Barry J.*; Cengage Learning.
9. Mechanics of Materials: *Andrew Pytel and Jaan Kiusalaas*, Cengage Learning.
10. Mechanics of Materials: *Timoshenko and Gere*, Tata McGraw Hill, New Delhi.
11. Mechanics of Materials: *James M. Gere*, Books/Cole.
12. Strength of Materials: *G.H. Ryder*, Mc-Millan.
13. Mechanics of Materials: *E.P. Popov*, Prentice Hall India (PHI) Pvt. Ltd.
14. Mechanics of Materials: *Pytel and Singer*, Mc-Graw Hill, New Delhi.
15. Strength of Materials: *William A. Nash and Nillanjan Mallick*, Mc-Graw Hill Book Co. (Schaum's Outline Series)

Semester-III

Course Code	Course Name	Credits
CEC 303	Engineering Geology	3

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
3		-	3		-	3

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	3 hrs		-		100

Rationale

Engineering geology is an applied geology discipline that involves the collection, analysis, and Interpretation of geological data and information required for the safe development of civil works. The objective of this course is to focus on the core activities of engineering geologists – site characterization, geologic hazard identification and mitigation. Through lectures, labs, and case study examination student will learn to couple geologic expertise with the engineering properties of rock in the characterization of geologic sites for civil work projects.

Understanding of the foundation rocks and structures present in them is of utmost importance for the safety and stability of Civil engineering structures. The study also helps in the assessment of groundwater, oil and gas and mineral resource evaluation.

Objectives

1. To acquire basic knowledge of Geology and to understand its significance in various civil engineering projects.
2. To study minerals and rocks in order to understand their fundamental characteristics and engineering properties.
3. To study structural geology for characterization of site, analysis and report geologic data using standards in engineering practice.
4. To study methods of subsurface investigation, advantages and disadvantages caused due to geological conditions and assessment of site for the construction of civil structures.
5. To study rock mass characterization for the construction of tunnels and assessment of rock as source of ground water.
6. To study the control of geology over the natural hazards and their preventive measures.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1	Introduction & Physical Geology		5
	1.1	Branches of geology useful to civil engineering, Importance of geological studies in various civil engineering Projects. Departments dealing with this subject in India and their scope of work- GSI, Granite Dimension Stone Cell, NIRM.	
	1.2	Internal structure of the Earth and use of seismic waves in understanding the interior of the earth. Theory of Plate Tectonics.	
	1.3	Weathering types, Erosion and Denudation. Factors affecting weathering and product of weathering (engineering consideration) Superficial deposits and its geological Importance.	
	1.4	Brief study of geological action of wind, glacier and river.	
2	Mineralogy and Petrology		7
	2.1	Identification of minerals with the help of physical properties, rock forming minerals, megascopic identification of primary and secondary minerals, study of common ore minerals.	
	2.2	Igneous Petrology - Mode of formation, Texture and structure, form of Igneous rocks, Classification of Igneous rocks, study of commonly occurring igneous rocks, Engineering aspect of Granite and Basalt.	
	2.3	Sedimentary Petrology - Mode of formation, Textures, characteristics of shallow water deposits like lamination, bedding, current bedding etc., classification, study of commonly occurring sedimentary rocks and their engineering application.	
	2.4	Metamorphic Petrology - Mode of formation, agents and types of metamorphism, structures and textures of metamorphic rocks, classification and study of commonly occurring metamorphic rocks and their engineering application.	
3	Structural Geology and Stratigraphy		12
	3.1	Dip and Strike. Outcrop and width of outcrop. Inliers and Outliers. Type of discontinuities in the rocks. Fold: Terminology, Classification on the basis of position of axial plane, Criteria for their recognition in field and engineering consideration. Fault: Terminology, Classification on the basis of movement of faulted block, Criteria for recognition in field, effects on outcrops and Engineering consideration.	

		Joints & Unconformity: Types and geological importance. Three point problems to determine attitude of the strata	
	3.2	Determination of thickness of the strata with the help of given data.	
	3.3	Geological Maps and their application for civil engineering works, Identification of symbols in maps.	
	3.4	General principles of Stratigraphy, geological time scale, Physiographic divisions of India and their characteristics. Stratigraphy of Deccan Volcanic Province.	
4	Geological Investigation, study of dam and reservoir site:		7
	4.1	Required geological consideration for selecting dam and reservoir site. Favorable & unfavorable conditions in different types of rocks in presence of various structural features, precautions to be taken to counteract unsuitable conditions.	
	4.2	Electrical resistivity and Seismic method of geological investigation. Rock Quality Designation and its importance to achieve safety and economy of the projects like dams and tunnels.	
	4.3	Borehole problems and their significance in determining subsurface geology of the area.	
5	Tunnel Investigation and Ground Water Control		5
	5.1	Importance of geological considerations while choosing tunnel sites and alignments of the tunnel, safe and unsafe geological and structural conditions.	
	5.2	Geo-mechanics classification (RMR) and its application.	
	5.3	Sources, zones, water table, unconfined, confined and Perched water tables. Factors controlling water bearing capacity of rocks, Pervious and Impervious rocks, Different types of rocks as source of ground water. Artesian well (flowing and non-flowing). Cone of Depression and its use in Civil engineering.	
6	Geological Disasters and Control Measures		3
	6.1	Landslides-Types, causes and preventive measures for landslides, Landslides in Deccan region.	
	6.2	Volcano- Central type and fissure type, products of volcano.	
	6.3	Earthquake- Terminology, Earthquake waves, construction and working of seismograph, Earthquake zones of India, elastic rebound theory, Preventive measures for structures constructed in Earthquake prone area.	

Contribution to Outcome

On completion of this course, the students will be able to:

- 1) Explain the concepts of Geology and its application for safe, stable and economic design of any civil engineering structure.
- 2) Interpret the lithological characters of the rock specimen and distinguish them on the basis of studied parameters.
- 3) Describe the structural elements of the rocks and implement the knowledge for collection and analysis of the geological data.
- 4) Interpret the geological conditions for the dam site and calculate RQD for the assessment of rock masses.
- 5) Analyze the given data and suggest rock mass rating for assessment of tunnelling conditions.
- 6) Interpret the causes of geological hazards and implement the knowledge for their prevention.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests** - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecturehours mentioned in the curriculum.

- 1) Question paper will comprise of total **six questions, each carrying 20 marks.**
- 2) **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
- 3) **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4) Only **Four questions need to be solved.**

Recommended Books:

- 1) Text book of Engineering Geology: N. Chenna, Kesavulu, Mc-Millan.
- 2) Text book of Engineering and General Geology, 8th edition (2010): Parbin Singh, S K Kataria& Sons.
- 3) Text book of Engineering Geology: P. K. Mukerjee, Asia.
- 4) Text book of Engineering Geology: Dr. R. B. Gupte, Pune VidyarthiGriha
- 5) Prakashan, Pune.
- 6) Principles of Engineering Geology: K. M. Banger.

Reference Books:

- 7) A Principles of Physical Geology: Arthur Homes, Thomas Nelson Publications, London.
- 8) Structural Geology, 3rd edition (2010): Marland P. Billings, PHI Learning Pvt. Ltd. New Delhi
- 9) Earth Revealed, Physical Geology: David McGeeary and Charles C. Plummer
- 10) Principles of Geomorphology: William D. Thornbury, John Wiley Publications, New York.
- 11) Geology for Civil Engineering: A. C. McLean, C.D. Gribble, George Allen &UnwinLondon.
- 12) Engineering Geology: A Parthsarathy, V. Panchapakesan, R Nagarajan, Wiley India 2013.

Semester - III

Course Code	Course Name	Credits
CEC304	Architectural Planning & Design of Buildings	02

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
02	-	-	02	-	-	02

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	---	-		100

Rationale

Drawing is the language of Civil Engineers to communicate. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field, on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Objectives

- 1) To remember and recall the intricate details of building design and drawing.
- 2) To gain an understanding of the basic concepts of building design and drawing.
- 3) To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices, rules, regulation and byelaws, Building codes
- 4) To identify, analyze, research literature and solve complex building design and drawing problems.
- 5) To have new solutions for complex building design and drawing problems.
- 6) To effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Course Outcomes

At the end of the course learners will be able to:

- 1) Remember and recall the intricate details of building design and drawing.
- 2) Understand the basic concepts of building design and drawing.
- 3) Learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
- 4) Identify, analyze, research literature and solve complex building design and drawing problems.
- 5) Have new solutions for complex building design and drawing problems.
- 6) Effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Detailed Syllabus		
Module	Sub- Modules/ Contents	Periods
1	Principles and Codes of Practices for Planning and Designing of Buildings(Residential and Public buildings)	8
1.1	Study of IS 962: 1989 – Code of Practice for Architectural and Building Drawings; How to develop Line plan into actual PLAN, ELEVATION, Section etc. including all the constructional details of various components in a BUILDING	
1.2	Principles of planning for Residential buildings	
1.3	Classification of buildings: Residential –Individual Bungalows & Apartments/Flats. Public – Education (Schools, Colleges etc.) &Health (Primary Health Center, Hospital) related buildings	
1.4	Study & drawing of SITE PLAN,FOUNDATION PLAN,ROOF PLAN of building; Study of building Bye – laws, Zoning Regulations and permissions required from commencement to completion of the building according to National Building Code (N.B.C.) of India and local Development Control (D.C.) rules	
1.5	Study of sun path diagram, wind rose diagram and sun shading devices	
1.6	Calculation of setback distances, carpet area, built-up area and floor spaceindex (FSI)	
1.7	Study of Principles of planning for public buildings: i) Building for education: schools, colleges, institutions etc. ii) Buildings for health: hospitals, primary health centers etc.	
2.	Components and Services of a Building	3
2.1	Staircase (dog -legged) planning, designing & drawing in details	
2.2	Foundations: stepped footing, isolated sloped footing and combined footing	
2.3	Openings: doors and windows	
2.4	Types of pitched roof and their suitability (plan and section)	
2.5	Building services: Water supply, sanitary and electrical layouts	
3.	Perspective Drawings	4
3.1	One-point perspective drawing	
3.2	Two-point perspective drawing	
4	Town Planning, Architectural Planning & Built Environment	3
4.1	Objectives and planning of TOWN PLANNING	
4.2	Master plan, Re-Development of buildings, Slum rehabilitation.	
4.3	Architectural Planning: introduction and principles	
4.4	Built Environment: introduction and principles	
5	Green Buildings	2
5.1	Introduction, uses ,objectives of Green Buildings and overview	
5.2	Study of Certification methods such as LEED, TERI, GRIHA, IGBC.	
6.	Computer Aided Drawing (CAD)	6
6.1	Details and learning methods of CAD in Civil Engineering structures	
6.2	Study and demonstration of any one of the professional CAD software's	
	Total	26

Theory Examination:

- 1) Only 4 questions (out of 6) need to be attempted.
- 2) Question no. 1 will be compulsory and based on the drawing work of any one building, may be residential or public building.. Some questions from the remaining may be on Theory portion.
- 3) 4. Any 3 out of the remaining 5 questions need to be attempted.
- 4) In question paper, weightage of each module maybe approximately proportional to the number of lecture hours assigned to it in the syllabus.

Internal Assessment:

There will be **Two** class tests (to be referred to as an ‘**Internal Assessment**’) to be conducted in the semester. The first internal assessment (IA-I) will be conducted in the mid of the semester based on the 50% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA-II) will be conducted at the end of the semester and it will be based on next 50% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively. Civil Engineering Drawing (including Architectural aspect) by *M. Chakraborti* (Monojit Chakraborti Publications, Kolkata)

Recommended Books

- 1) Planning and Designing Buildings by Y. S. Sane (Modern Publication House, Pune)
- 2) Building Drawing and Detailing by B.T.S. Prabhu, K.V. Paul and C. V. Vijayan (SPADES Publication, Calicut)
- 3) Building Planning by Gurucharan Singh (Standard Publishers & Distributors, New Delhi)

References:

- 1) IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
- 2) National Building Code of India – 2005 (NBC 2005)
- 3) Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (<https://mmrda.maharashtra.gov.in>)
- 4) Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (<https://www.nmmc.gov.in/development-control-regulations>)
- 5) Development Plan and Control Regulation KDMC, <https://mmrda.maharashtra.gov.in>

Reference Codes:

- 1) National Building Code of India, 2005
- 2) IS 779-1978 Specification for Water Meter
- 3) IS 909-1975 Specification for Fire Hydrant
- 4) IS 1172-1983 Code of Basic Requirement for Water Supply, Drainage & Sanitation
- 5) IS 1742-1983 Code of Practice for Building Drainage

Semester- III

Course Code	Course Name	Credits
CEC305	Fluid Mechanics - I	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	-	-	-	

Rationale

The concept of fluid mechanics in civil engineering is essential to understand the processes and science of fluids. The course deals with the basic concepts and principles in hydrostatics, hydro kinematics and hydrodynamics with their applications in fluid flow problems.

Objectives

The students will be able to learn:

1. The properties of fluids, units and dimensions
2. Pressure measurement, manometry, Hydrostatic forces acting on different surfaces, Principle of buoyancy and stability of floating body
3. Kinematic and Dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations.
4. Importance of fluid flow and various velocity measuring and discharge measuring devices used in pipes and channels.
5. The basic difference between incompressible and compressible flow, Propagation of pressure waves and stagnation points.

Detailed Syllabus			
Module		Course Modules / Contents	Periods
1		Properties of Fluids	05
		Mass density, weight density, specific gravity, specific volume, viscosity, compressibility and elasticity, surface tension, capillarity, vapour pressure, types of fluids, and introduction to real life applications.	
2		Fluid Statics	11
	2.1	Pressure Measurement: Pascal's law, hydrostatic law, pressure variation in fluids at rest. Pressure scale, Absolute, atmospheric, gauge pressure, measurement of pressure using manometers	
	2.2	Hydrostatic force on surfaces:	

		Total pressure and centre of pressure, total pressure on horizontal planesurface, vertical plane surface, Inclined plane surface, centre of pressure for vertical plane surface and for inclined plane surface, practical applications of total pressure and centre of pressure on dams, gates, and tanks.	
	2.3	Buoyancy and floatation: Archimedes principle, Meta-Centre, metacentric height, Stability of floating and submerged bodies, determination of metacentric height, Experimental and analytical methods, metacentric height for floating bodies containing liquid, Time period of Transverse oscillations of floating bodies.	
3		Fluid Kinematics Types of fluid flow, description of flow pattern, Lagrangian methods, Eulerian method, continuity equation, velocity and acceleration of fluid particles, streamline, streak line, path line, velocity potential and stream function, equipotential lines and flow net, uses of flow net, rotational and irrotational motions, circulation and vorticity	05
4		Fluid Dynamics Control volume and control surface, Forces acting on fluid in motion, Navier Stokes Equation, Euler's Equation of motion, Integration of Euler's equations of motion, Bernoulli's Theorem and its derivation, Bernoulli's equation for compressible fluid and real fluid, practical applications of Bernoulli's Equation - Venturimeter, Orifice meter, nozzle meter, pitot tube, Rota meter.	06
5		Flow measurement	08
	5.1	Orifices and mouthpieces Classification of orifices, flow through orifices, determination of hydraulic coefficients, flow through large rectangular orifice, flow through fully submerged and partially submerged orifice, time of emptying a tank through an orifice at its bottom. Classification of Mouthpieces, Flow through external cylindrical mouthpiece, convergent-divergent mouthpiece, Borda's mouthpieces.	
	5.2	Notches and weirs Classification of notches and weirs, discharge over a rectangular, triangular, trapezoidal notch/weir, velocity of approach, stepped notch, Cipolletti weir, broad crested weir, ogee weir, discharge over a submerged weir, ventilation of weirs.	
6	6.1	Compressible flow	04
		Basic equation of flow (elementary study), velocity of sound or pressure wave in a fluid, Mach number, propagation of pressure waves, area-velocity relationship, Stagnation properties.	
Total			39

Contribution to Outcome

Upon completion of the course, students shall have ability to:

- 1) Describe various properties of fluids and types of flow
- 2) Determine the pressure difference in pipe flows, application of Continuity equation and Bernoulli's theorem to determine velocity and discharge
- 3) Apply hydrostatic and dynamic solutions for fluid flow applications
- 4) Analyse the stability of floating bodies
- 5) Apply the working concepts of various devices to measure the flow through pipes and channels
- 6) Explain the compressible flow, propagation of pressure waves and stagnation properties

Internal Assessment (20 Marks):

Consisting Two Compulsory Class Tests:

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1) Question paper will comprise of total **six questions, each carrying 20 marks.**
- 2) **Question 1** will be compulsory and should **cover maximum contents of the curriculum**
- 3) **Remaining questions will be mixed in nature**(for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4) Only **Four questions need to be solved.**

Recommended Books:

- 1) Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi
- 2) Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
- 3) Fluid Mechanics: Dr. A.K Jain, Khanna Publishers.
- 4) Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt.Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
- 5) Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
- 6) Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

Reference Books:

- 1) Fluid Mechanics: Frank M. White, Tata McGraw Hill International Edition.
 - 2) Fluid Mechanics: Streeter White Bedford, Tata McGraw International Edition.
 - 3) Fluid Mechanics with Engineering Applications: R.L. Daugherty, J.B. Franzini, E.J. Fennimore, Tata McGraw Hill, New Delhi.
 - 4) Hydraulics: James F. Cruise, Vijay P. Singh and Mohsen M. Sherif, CENGAGE Learning India (Pvt.) Ltd.
 - 5) Introduction to Fluid Mechanics: Edward J. Shaughnessy, Jr, Ira M. Katz, James P. Schaffer. Oxford Higher Education.
-

Semester- III

Course Code	Course Name	Credits
CEL301	Mechanics of Solids- LAB	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Objectives

- 1) To learn stress - strain behavior and physical properties of materials and to compute the Stresses developed and deformation of Elastic members.
- 2) To compute the distribution of shear stress and the flexural (bending) stress across the cross section of structural members
- 3) To study circular shafts under the action of twisting moment.
- 4) To learn the computation of slope and deflection of elastic beams and general theorems used in this computation.

Outcomes

Learner will be able to...

- 1) Evaluate stress - strain behavior of materials and assess the structural behavior by the virtue of stresses developed and deformation of elastic members.
- 2) Analyze the material response under the action of shear and the effect of flexure (bending).
- 3) Predict the angle of twist and shear stress developed in torsion.
- 4) Evaluate slope and deflection of beams supported and loaded in different ways.

Term Work :Term work comprises of Laboratory work and assignments.

Laboratory work : (At least 6- Performances - Any one from each Module)

Mechanics of Solids (Practical performance)		
Schedule	Name of Experiment	Duration (Hours)
1st week	1) Using UTM find different Moduli of a material or 2) The Tension Test on M S rod or 3) The Tension Test on M S Flat	2
3rd week	1) The Compression Test on Concrete cube or 2) The Compression Test on Timber or 3) The Compression Test on Brick	2
5th week	1) Test of Bending Using a Strain Guage or 2) Test of Bending Using a other electronic devices or 3) Test of Shear Stress in Beams	2
7th week	1) Using TorsionTesting Machine, verify the torsion equation, find different Moduli of a material. or 2) Spring Stiffness Test using strain gauges or other electronic devices	2
9th week	1) Charpy impact testing and Energy concept. or 2) Izod impact testing and Energy concept.	2
11th week	1) Using U T M perform experiments and verify Slope and deflection equations, 3 points and 4 points loading. (Performance) or 2) Deflection of Simply supported Beams (Performance) or 3) Deflection of Cantilever Beams (Performance)	2
Total Duration = 12 Hours		

Assignment:

(At least 1 from each module as per the Course instructor's guidelines; it is to be assessed during Laboratory hours. In order to avoid Copying/ repetition, Course Instructor may give different assignments to different groups.)

Mechanics of Solids		
Schedule	Assignment	Duration (Hours)
2nd week	Stresses and strains in Elastic members, Spherical and Cylindrical shells • Prepare a model of Cylindrical vessel or • Prepare a model of spherical vessel or • Prepare a model of Cylindrical vessel with hemispherical ends or • Prepare a chart showing diagrammatic representation of stresses or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • Write a Computer program in C++ or MSExcel on how to find a particular quantity from given data (Ex: Find output, Elongation 'δ' from the input values of P,L,A and E) • A chart about scientists and their contribution to the study of 'Mechanics of Solids' (Example given at the end of this document – Appendix I)	2

4 th week	Axial force, shear force and bending moment diagrams for beams and portal frames • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of ‘Mechanics of Structures’ (Example given at the end of this document) or • Prepare a chart showing AFD, SFD & BMD for different symmetric and asymmetric loads on S S beams or • Prepare a chart showing AFD, SFD & BMD for different loads on Cantilever beams	2
6 th week	Area Moment of Inertia, Bending stresses and Shear stresses in beams • Prepare a chart showing MI @ XX, YY & ZZ axes passing through the centroid. or • Prepare 3D models of different typical cross sections of beams and find their cross sectional area, I_{xx}, I_{yy} and I_{zz}. or • Prepare charts showing typical cross sections and variation of Bending stresses and shear stresses across the cross section. or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • Write a Computer program in C++ or MS Excel on how to find a particular quantity from given data (Ex: Find output, Flexural stress ‘f’ from the input values of P,L,I and E) • A chart about scientists and their contribution to the study of ‘Mechanics of Structures’ (Example given at the end of this document)	2
8 th week	Torsion of Shafts, Columns • Prepare 3D models of different solid and hollow circular cross sections of shafts and find their cross sectional area, I_{xx}, I_{yy} and I_{zz}. or • A set of 5 questions on a module designed by course instructor, or • Write a Computer program in C++ or MS Excel on how to find a particular quantity from given data (Ex: Find output, Shear stress ‘q’ or angle ‘Θ’ from the input values of T,L,G and J) • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of ‘Mechanics of Solids’ (Example given at the end of this document)	2
10 th week	Principal planes and stresses, Strain Energy • Draw typical stress transformation cases of Mohr’s circle using graph paper. or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of ‘Mechanics of Solids’ (Example given at the end of this document)	2

12th week	Slope and Deflection in Beams ; General Theorems • Prepare chart to explain General theorems for slope and deflection. or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of ‘Mechanics of Solids’ (Example given at the end of this document)	2
Total Duration = 12 Hours		

Appendix -I:

A chart about scientists and their contribution to the study of ‘Mechanics of solids’ be made by students. Contributions of Scientists like Giordano Riccati, Leonhard Euler, Saint Venant, Christian Otto Mohr, William J M Rankine, Carlo Castiglione, Enrico Betti, Robert Hooke, W. H. Macaulay, Augustin- Louis Cauchy, Simeon Poisson can be studied and presented.

Important Websites:

- 1) [http://www.iitk.ac.in/mseold/mse_new/facilities/laboratories/Material Testing Lab / MSE313A.pdf](http://www.iitk.ac.in/mseold/mse_new/facilities/laboratories/Material_Testing_Lab_/MSE313A.pdf)
- 2) [https://home.iitm.ac.in/kramesh/Strength of Materials Laboratory Manual.pdf](https://home.iitm.ac.in/kramesh/Strength_of_Materials_Laboratory_Manual.pdf)
- 3) https://www.researchgate.net/publication/338139499_Me_8381-Strength_Of_Materials_Lab_Manual

Assessment:

To be done in 13th week

● Term Work:

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory work- : 15 Marks

Assignments- : 10 Marks

The sum will be multiplied by a factor of attendance between 0.5 (for poor attendance) to 1 (very good attendance).

● End Semester Oral Examination

Oral examination will be based on entire syllabus

Semester- III		
Course Code	Course Name	Credits
CEL302	Engineering Geology Lab. Practice	1

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	2	-	-	1	-	1

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	3 hrs	25	-	25	50

Objectives

1. To acquire basic knowledge of Geological Lab practices and apply it for the safe development of Civil Engineering works.
2. To examine the mineral and rock sample and understand their fundamental properties for their evaluation as construction and foundation material.
3. To study the Geological maps and their sections in terms of selecting the sites for various civil engineering structures.
4. To study Borehole problems for determination of subsurface geology of the area.
5. To Study the drilling data and calculate RQD for assessment of rock masses for Civil Engineering purposes.

Outcomes

Learner will be able to...

1. Identify various rock forming minerals on the basis of physical properties.
2. Explain the characteristics of Igneous, Sedimentary and Metamorphic rocks and assess their suitability as construction material and foundation rock.
3. Interpret the rock characteristics and comment on their suitability as water bearing horizons.
4. Interpret the geological map and assess the suitability of the site for Civil Engineering works.
5. Solve the borehole problems and interpret it in order to understand subsurface Geology of the area.
6. Calculate RQD and evaluate the rock masses for Civil Engineering Works.

A) List of Experiments

Module	Detailed Contents	Lab Sessions/Hr
1	Study of Physical Properties of Minerals: Identification of common Rock forming minerals on the basis of physical Properties- Silica Group: Quartz and its varieties; Cryptocrystalline silica: Jasper and Agate; Feldspar Group: Orthoclase, Plagioclase; Carbonate Group: calcite; Amphibole Group: Asbestos, Actinolite and Hornblende; Pyroxene Group: Augite; Mica Group: Muscovite, Biotite and Talc; Element Group: Graphite.	6
2	Identification of Metallic minerals: Galena, Pyrite, Hematite, Magnetite.	2
3	Identification of rocks: Igneous Rocks- Granite and its varieties, Syenite, Diorite, Gabbro, Pegmatite. Porphyry, Dolerite, Rhyolite, Pumice, Trachyte, Basalt and its varieties, Volcanic Breccia, Volcanic Tuffs.	4
4	Sedimentary Rocks- Conglomerate, Breccia, Sandstone and its varieties, Shales, Limestones, Laterites.	2
5	Metamorphic Rocks- Schist and its varieties, Gneiss and its varieties, Slate, Marbles, Quartzite and Phyllite.	2
6	Geological Maps: a) Horizontal strata: Drawing the cross section and assessment of geological history of the area. b) Inclined Strata: Calculation of dip and strike in an inclined strata and assessment of geological history of the area. c) Assessment of the geological conditions for a proposed dam site in the given map. d) Assessment of the geological conditions for a proposed tunnel site in the given map. e) Assessment of the geological conditions for groundwater reserve in the given map.	6
7	Borehole problems to interpret subsurface geology	2
8	Calculation of RQD from the given data and assessment of rock quality.	2

B) Assessment:

● Term Work

Including Laboratory Work and Assignments both, Distribution of marks for Term Work Shall be as follows:

Laboratory work-	:	10 Marks
Assignments-	:	10 Marks
Attendance	:	05 Marks

● End Semester Oral Examination

Oral examination will be based on the entire syllabus.

Semester- III

Course Code	Course Name	Credits
CEL 303	Architectural Planning & Design of Buildings Lab	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

@ For the course ‘Building Design and Drawing, the oral examination shall be conducted in conjunction with the sketching examination.

Rationale

Drawing is the language of Civil Engineers to communicate. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field, on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Course Objectives

- 1) To remember and recall the intricate details of building design and drawing.
- 2) To gain an understanding of the basic concepts of building design and drawing.
- 3) To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
- 4) To identify, analyze, research literature and solve complex building design and drawing problems.
- 5) To have new solutions for complex building design and drawing problems.
- 6) To effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Course Outcomes:

At the end of the course, learners will be able to:

- 1) Plan and design of residential and public building by implementing the principles of planning of buildings, Green building principles, byelaws, regulations and codes for planning

- 2) Preparing various working and detailed drawing of the buildings in CAD.
- 3) Preparing layouts of various building services.
- 4) Preparing perspective views for all types of buildings
- 5) Preparing the reports based on the drawings prepared, if required

Practical:

Students should make all the drawings during the Practical time allotted to them.

- 1) Drawings (Manually) should be drawn in the allotted Drawing hall only.
- 2) Drawings (CAD sheets) should be drawn on the Desktop/Laptop in Computational Lab.

After completing the work, Print out of those sheets should be submitted for gradation/Marks.

Assignments:

Two Assignments should be completed, covering all the modules in the syllabus.

- 1) Assignment-1 should be on 50% of the syllabus, to be completed before Internal Assessment-I exam.
- 2) Assignment-2 should be on the remaining 50% of the Syllabus, to be completed before Internal Assessment-II exam.

Site Visit:

Students should visit any Residential building/Public building physically and take Measurements inside of all rooms & over all outside of the building & can submit a small drawing sheet with the help of CAD. (**Optional** only)

Practical Examination (Oraland Sketching)

Practical examination will consist of sketching and oral examination based on the entire syllabus.

Term Work:

Drawings & Assignments:

- 1) Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, Site plan, Foundation Plan and details of one FOOTING, Roof Plan ,schedule of opening and construction notes of a **residential building(bungalow or apartment)** to be constructed as a (G+1) R.C.C. framed structure (**only Manual Drawing**)
- 2) **One-Point** Perspective drawing for any Residential structure(**only Manual drawing**)
- 3) Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, schedule of opening and construction notes of a **public building(Education/Health related)** be constructed as a (G+1) R.C.C. framed structure (**only CAD drawing Sheet**)
- 4) **Two-Point** perspective drawing for any one public building (**only CAD drawing Sheet**)
- 5) Assignment No.- 1
- 6) Assignment No.- 2

Distribution of Term-work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification acceptance of term-work warrants the satisfactory completion of the required quality & quantity of work for the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

	Particulars	Marks
1	Drawing Sheet (Manual)	7.5 Marks
2	Drawing Sheet (CAD Based)	7.5 Marks
3	Assignments	5 Marks
4	Attendance	5 Marks
	Total	25 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to. 75% 80%: 03 Marks; 81% 90%: 04 Marks 91% onwards: 05 Marks (**Consider Practical attendance**)

Recommended Books:

- Building Drawing with an Integrated Approach to Built Environment by *M. G. Shah, C. M. Kale, S.Y. Patki*(Tata McGraw-Hill Education)
- Civil Engineering Drawing (including Architectural aspect) by *M. Chakraborti* (MonojitChakraborti Publications, Kolkata)
- Planning and Designing Buildings by *Y. S. Sane* (Modern Publication House, Pune)
- Building Drawing and Detailing by *B.T.S. Prabhu, K.V. Paul and C. V. Vijayan* (SPADES Publication, Calicut)
- Building Planning by *Gurucharan Singh* (Standard Publishers & Distributors, New Delhi)

References:

- IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
- National Building Code of India – 2005 (NBC 2005)
- Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (<https://mmrda.maharashtra.gov.in>)
- Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (<https://www.nmmc.gov.in/development-control-regulations>)
- Development Plan and Control Regulation KDMC, <https://mmrda.maharashtra.gov.in>

Reference Codes:

- National Building Code of India, 2005
- IS 779-1978 Specification for water meter
- IS 909-1975 Specification for fire hydrant
- IS 1172-1983 Code of basic requirement for water supply ,drainage & sanitation
- IS 1742-1983 code of practice for building drainage

Semester- III

Course Code	Course Name	Credits
CEL304	Fluid Mechanics – I (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

The students will be able to learn:

1. The basic fluid mechanics concepts
2. Measuring pressure, velocity and discharge of fluid flow through pipes and channels

Course Outcomes:

At the end of the course, learner will be able to:

1. Calculate the metacentric height
2. Verify the Bernoulli's theorem
3. Determine the discharge coefficients
4. Measure fluid flow using various devices
5. Determine the hydraulic coefficients of an orifice

List of Experiments (Minimum Six)

Module	Detailed Contents	Lab Sessions/Hr
1	Determination of the Metacentric height of a floating body	02 hrs
2	Investigating the validity of the Bernoulli equation applied to a steady flow of water through a tapered duct	04 hrs
3	Determination of coefficient of discharge of Venturimeter.	02 hrs
4	Determination of coefficient of discharge of Orifice meter.	02 hrs
5	Determination of coefficient of discharge of Nozzle meter.	04 hrs
6	Determination of coefficient of discharge of Notches (Rectangular and Triangular notch).	02 hrs
7	Determination of coefficient of discharge of weirs (Broad Crested weir and Ogee weir).	04 hrs
8	To determine the value of coefficient of contraction, coefficient of velocity and coefficient of discharge for the given orifice	04 hrs
9	Determination of coefficient of discharge of mouthpiece.	02 hrs

Assessment:

Term Work

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory work	:	15 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

End Semester Oral Examination

Oral examination will be based on entire syllabus.

Reference Books:

- Fluid Mechanics and Hydraulic Machines: R. K. Rajput, S. Chand and Company
- Hydraulics and Fluid mechanics: Dr.P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi
- Hydraulics Fluid Mechanics and Fluid Machines: S. Ramamrutham, DhanpatRai Publishing Company (P) Ltd-New Delhi
- Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
- Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
- Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
- Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

Semester-III

Course Code	Course Name	Credits
CEL305	Skill Based Lab Course-I Computer Aided Drafting & Building Information Modelling	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	3	-	-	1.5	-	1.5

Theory					Term Work /Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	50	-	-	50

Objectives:

1. To enable the learners efficiently draft and label buildings components using the concepts of 2D and 3D drawing and detailing
2. To introduce the concepts of object-based modelling in 3-D environment to learners
3. To enable the learners to work on drawing and drafting softwares so that they can conveniently understand and design civil engineering components through the softwares.

Outcomes: Learner will be able to...

1. Transfer the plan from a drawing sheet to a 2-D drafting software
2. Visualize the various elements in the software like points, lines, polygons, etc. as objects of the real world and relate it with civil engineering components.
3. Apply civil engineering concepts to draft efficient civil engineering plans in accordance to various building bye laws and forms.
4. Conceptualize the space, logistic and statutory constraints in the real world to draw an efficient plan so that optimization is achieved
5. Attach and retrieve information pertaining to various civil engineering components through 3-D modelling software
6. Demonstrate a virtual walkthrough of buildings

C) List of Experiments (Minimum Eight)

Module	Detailed Contents	Lab Sessions/Hr
1	Listing out the various Computer Aided Drawing and Drafting (CADD) tools available for civil engineering projects in the market and highlighting the capabilities and advantages of each	03
2	Basic introduction to compatibilities, utilities and attributes of peculiar drafting softwares w.r.t their various commands, features, capabilities and functions.	03
3	Line plan of a residential structure using a CADD tool	03

4	Developed plan of a residential structure (minimum G+4) using a CADD tool	06
5	Developed plan of a public building using a CADD tool	06
6	Basic introduction to compatibilities, utilities and attributes of peculiar building information modelling (BIM) softwares w.r.t their various commands, features, capabilities and functions.	03
7	Creating families and basic models on BIM	06
8	Creating architectural plan on BIM of a G+1 bungalow	03
9	Demonstrating a walkthrough on BIM for clients and presenting it	03
10	Clash detection and removal	03

D) Assessment:

● Term Work

Including Laboratory Work comprising of minimum 6 software generated sheets and one walkthrough presentation on BIM, distribution of marks for Term Work shall be as follows:

Laboratory work	:	30 Marks (comprising of minimum 6 software generated sheets)
Presentation	:	10 Marks (showing 3-D walk through the building)
Attendance	:	10 Marks

Semester- III

Course Code	Course Name	Credits
CEM 301	Mini Project -1 A	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to...

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;

• Marks awarded by guide/supervisor based on log book	:	10
• Marks awarded by review committee	:	10
• Quality of Project report	:	05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
- First shall be for finalisation of problem
- Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
- First review is based on readiness of building working prototype to be conducted.
- Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
 - Identification of need/problem
 - Proposed final solution
 - Procurement of components/systems
 - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
 - First shall be for finalisation of problem and proposed solution
 - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

- 1) Quality of survey/ need identification
 - 2) Clarity of Problem definition based on need.
 - 3) Innovativeness in solutions
 - 4) Feasibility of proposed problem solutions and selection of best solution
 - 5) Cost effectiveness
 - 6) Societal impact
 - 7) Innovativeness
 - 8) Cost effectiveness and Societal impact
 - 9) Full functioning of working model as per stated requirements
 - 10) Effective use of skill sets
 - 11) Effective use of standard engineering norms
 - 12) Contribution of an individual's as member or leader
 - 13) Clarity in written and oral communication
- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
 - In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

- 1) Quality of problem and Clarity
- 2) Innovativeness in solutions
- 3) Cost effectiveness and Societal impact
- 4) Full functioning of working model as per stated requirements
- 5) Effective use of skill sets
- 6) Effective use of standard engineering norms
- 7) Contribution of an individual's as member or leader
- 8) Clarity in written and oral communication

Second Year Civil Engineering
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)
Semester – IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			Total
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	
CEC401	Engineering Mathematics - IV	3	--	1	3	-	1	4
CEC402	Structural Analysis	4	--	-	4	-	-	4
CEC403	Surveying	3	--	-	3	-	-	3
CEC404	Building Materials & Concrete Technology	3	--	-	3	-	-	3
CEC405	Fluid Mechanics-II	3	-	-	3	-	-	3
CEL 401	Structural Analysis	--	2	-	-	1	-	1
CEL 402	Surveying	--	3	-	-	1.5	-	1.5
CEL 403	Building Material Concrete Technology	--	2	-	-	1	-	1
CEL 404	Fluid Mechanics-II	--	2	-	-	1	-	1
CEL 405	Skill Based lab Course	--	2	-	-	1	-	1
CEM401	Mini Project – 1 B	--	3 ^s	-	-	1.5	-	1.5
Total		16	14	1	16	7	1	24

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)-	Term Work	Prac. /Oral	Total
		Test I	Test II	Avg .					
CEC 401	Engineering Mathematics - IV	20	20	20	80	3	25	-	125
CEC 402	Structural Analysis	20	20	20	80	3	-	-	100
CEC 403	Surveying	20	20	20	80	3	-	-	100
CEC 404	Building Materials & Concrete Technology	20	20	20	80	3	-	-	100
CEC 405	Fluid Mechanics-II	20	20	20	80	3	-	-	100
CEL 401	Structural Analysis						25	25	50
CEL 402	Surveying						50	25	75
CEL 403	Building Materials & Concrete Technology	-	-	-	-	-	25	25	50
CEL 404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL 405	Skill Based lab Course	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1 B	-	-	-	-	-	25	25	50
	Total			100	400	-	225	125	850
Semester- IV									

Course Code	Course Name	Credits
CEC 401	Engineering Mathematics-IV	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	01	03	-	01	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	25	-	-	125

Pre-requisite:

- Engineering Mathematics-I,
- Engineering Mathematics-II,
- Engineering Mathematics-III,

Objectives:

- 1) To study the concept of Vector calculus & its applications in engineering.
- 2) To study Line and Contour integrals and expansion of complex valued function in a power series.
- 3) To familiarize with the concepts of statistics for data analysis.
- 4) To acquaint with the concepts of probability, random variables with their distributions and expectations.
- 5) To familiarize with the concepts of probability distributions and sampling theory with its applications.

Outcomes: Learner will be able to....

- 1) Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's theorem & Gauss Divergence theorem.
- 2) Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
- 3) Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.
- 4) Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
- 5) Apply the concept of probability distribution to engineering problems & Testing hypothesis of small samples using sampling theory
- 6) Apply the concepts of parametric and nonparametric tests for analysing practical problems.

Module	Detailed Contents	Hrs.
01	Module : Vector Calculus 1.1 Solenoidal and irrotational (conservative) vector fields. 1.2 Line integrals – definition and problems. 1.3 Green’s theorem (without proof) in a plane, Stokes’ theorem (without Proof), Gauss’ Divergence theorem (without proof) and problems (only evaluation). Self Learning Topics: Identities connecting Gradient, Divergence and Curl, Angle between surfaces. Verifications of Green’s theorem, Stoke’s theorem & Gauss-Divergence theorem, related identities & deductions.	07
02	Module: Complex Integration 2.1 Line Integral, Cauchy’s Integral theorem for simple connected and multiply connected regions (without proof), Cauchy’s Integral formula (without proof). 2.2 Taylor’s and Laurent’s series (without proof). 2.3 Definition of Singularity, Zeroes, poles of $f(z)$, Residues, Cauchy’s Residue Theorem (without proof) Self-learning Topics: Application of Residue Theorem to evaluate real integrations.	07
03	Module: Statistical Techniques 3.1 Karl Pearson’s Coefficient of correlation (r) and related concepts with problems 3.2 Spearman’s Rank correlation coefficient (R) (Repeated & non repeated ranks problems) 3.3 Lines of regression 3.4 Fitting of first and second degree curves. Self-learning Topics: Covariance, fitting of exponential curve.	06
04	Module: Probability Theory: 4.1 Conditional probability, Total Probability and Baye’s Theorem. 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, 4.3 Expectation, Variance, Co-variance, moments, Moment generating functions, (Four moments about the origin & about the mean). Self- learning Topics: Properties variance and covariance,	06
05	Module: Probability Distribution and Sampling Theory-I 5.1 Probability Distribution: Poisson and Normal distribution 5.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 5.3 Students’ t-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t- test) Self -learning Topics: Test of significance of large samples, Proportion test, Survey based project.	07
06	Module: Sampling theory-II 6.1 Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate’s Correction. 6.2 Analysis of variance: F-test (significant difference between variances of two samples) Self- learning Topics: ANOVA: One way classification, Two-way classification (short-cut method).	06

Term Work:

General Instructions:

- 1) Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practical.
- 2) Students must be encouraged to write at least 6 class tutorials on entire syllabus.
- 3) A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- Question paper will comprise of total six questions, each carrying 20 marks
- Question 1 will be compulsory and should cover maximum contents of the curriculum
- Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four questions need to be solved.

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Vector Analysis, Murray R. Spiegel, Schaum Series
5. Complex Variables and Applications, Brown and Churchill, McGraw-Hilleducation
6. Probability Statistics and Random Processes, T. Veerarajan, Mc. GrawHilleducation.

Semester-IV								
Course Code			Course Name					Credits
CEC402			Structural Analysis					4
Contact Hours				Credits Assigned				
Theory		Practical	Tutorial	Theory	Practical	Tutorial		Total
4		-	-	4	-	-		4
Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	3 hrs	-	-	-	
Rationale								

Different components of civil engineering structures are subjected to various force systems and their combinations. For designing the components, these are analyzed for their response. The structural systems are determinate or indeterminate in nature and so there are different analysis methods. These will be learnt in this course. Subject knowledge of Engineering Mechanics and Mechanics of solids is the prerequisite of this course.

Their application on solids and mechanisms, the action of force systems is studied and further extended in this subject. Learner will learn to apply these to the analysis of various members of structural systems such as beams, trusses, portal frames and arches. These analyses will further be used while designing of Steel and RCC structures.

Objectives

1. To analyze for axial force in the Coplanar, perfect trusses and analysis of 3- Hinged arches.
2. To study the concept of Influence Line Diagrams for Reactions, SF and B M in beams and axial forces in trusses and their application for rolling load systems.
3. To learn methods for evaluating rotation and displacement parameters in respect of frames and trusses using various methods. To understand static and kinematic indeterminacy of structures.
4. To analyze the indeterminate structures using Flexibility methods and Using Clapeyron's Theorem..
5. To analyze the indeterminate structures such as beams & simple rigid jointed frames using direct stiffness method.
6. To analyze the indeterminate structures using Moment Distribution as Stiffness method and Plastic analysis of structures.

Detailed Syllabus			
Module		Course Modules / Contents	Duration
1		Trusses and 3 hinged Arches	(9)
	1.1	Trusses: Analysis of Perfect Coplanar Trusses by Method of Joints (3) Analysis of Perfect Coplanar Trusses by Method of sections.(3)	6
	1.2	Three hinged elastic arches, Determination of normal thrust, radial shear and bending moment for Symmetrical & Unsymmetrical parabolic three hinged arches.(3)	3
2		Influence line diagrams and rolling loads	(09)
	2.1	Influence lines for Reactions, shear force and bending moment at a section of cantilever, simply supported, overhanging beams without internal hinges. (2) Rolling loads, Determination of S F and BM at a section, Value and criteria for maximum shear force and bending moment, absolute maximum shear force and bending moment under rolling loads (UDL and series of point loads) for simply supported girder. (4)	6
	2.2	I L D for Axial forces in members of Pin jointed trusses (3)	3
3		Determinate and Indeterminate structures	(8)
	3.1	Deflection of Statically determinate structures, methods based on energy principles and Castigliano's theorems to evaluate deflection in portal frames, bent up and arch type structures. Application of Unit Load Method for calculating slope and deflection of a point on rigid jointed frames and deflection of a point on Pin jointed truss.	5
	3.2	Static and kinematic indeterminacies: Types of structures occurring in practice, their classification, linear and non-linear behavior of materials, geometric non-linearity, static and kinematic determinacy and indeterminacy of structure.	3
4		Analysis of indeterminate structures by Flexibility method	(9)
	4.1	Analysis of fixed beam. Application of Clapeyron's theorem of three moments to fixed beam and continuous beam.	4
	4.2	Flexibility coefficients and their use in formulation of compatibility equations. Application of flexibility method to propped cantilevers, fixed beams & continuous beams, Simple rigid jointed frames.	5
5		Analysis of indeterminate structures by Stiffness method	(8)
	5.1	Direct stiffness method: Stiffness coefficients for prismatic members and their use for formulation of equilibrium equations.	4
	5.2	Application of Direct stiffness method to indeterminate beams & simple rigid jointed frames.	4
6		Moment distribution method and Plastic Analysis of structures.	(9)

	6.1	Moment distribution method: Application to indeterminate beams & simple rigid jointed frames & frame with inclined member but having only single translation degree of freedom including the effect of support settlement.	5
	6.2	Plastic analysis of structures: Introduction to plastic analysis, concept of plastic hinge, plastic moment carrying capacity, shape factor. Static and kinematic method of plastic analysis. Determination of collapse load for single and multiple span beams.	4

Contribution to Outcome

On completion of this course, the students will be able to:

1. Calculate axial forces in the Coplanar trusses by using Method of joints and method of sections and also calculate radial shear, normal thrust and bending moment in parabolic 3-Hinged arches.
2. Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them..
3. Evaluate rotation and displacement at a joint of frames and deflection at any joint of truss and will be able to compute static and kinematic indeterminacy of structure.
4. Apply Flexibility methods and make use of Clapeyron's Theorem to analyze the indeterminate structures.
5. Analyse the indeterminate structures such as beams & simple rigid jointed frames using direct stiffness method.
6. Analyse the indeterminate structures using Moment Distribution as Stiffness method and make plastic analysis.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1) Question paper will comprise of total **six questions, each carrying 20 marks.**
- 2) **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
- 3) **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- 4) Only **Four questions need to be solved.**

Recommended Books:

1. Basic Structural Analysis: C.S. Reddy, Tata McGraw Hill New Delhi.
2. Mechanics of Structures: Vol-I: S. B. Junnarkar and H.J. Shah, Charotar Publishers, Anand.
3. Analysis of Structures: Vol. I and II, Vazirani and Ratwani

4. Strength of Materials: S. Ramamrutham, Dhanpatrai and Publishers, Delhi
5. Theory of Structures: S. Ramamrutham, Dhanpatrai and Sons, Delhi
6. Structural Analysis I: HemantPatil, YogeshPatil, Jignesh Patel, Synergy Knowledgeware, Mumbai.
7. Strength of Materials: Rajput, S. Chand Publications, Delhi
8. Structural Analysis: Bhavikatti, Vikas publisher house Pvt, ltd.
9. Structural Analysis: DevdasMenon, Narosa Publishing House.
10. Basic Structural Analysis: K.U. Muthu, Azmi Ibrahim, M. Vijayanand,
11. MagantiJanadharnand. I.K.International Publishing House Pvt. Ltd.
12. Comprehensive Structural Analysis: Vol-I and II by Vaidyanathan R. and Perumal R.LaxmiPublications.
13. Elementary Structural Analysis: Jindal
14. Structural Analysis: L.S. Negi and R.S. Jangid, Tata Mc-Graw Hill India
15. Fundamentals of Structural Analysis: Sujit Kumar Roy and SubrotaChakrabarty, S. Chand Publications.
16. Structural Analysis: T.S. Thandavamoorthy, Oxford University Press.
17. Structural Analysis: Manmohan Das, Bharghab Mohan Pentice Hall International. .

Reference Books:

1. Structural Analysis: *Hibbler*, Pentice Hall International.
2. Structural Analysis: *Chajes*, ElBS London.
3. Theory of Structures: *Timoshenko and Young*, Tata McGraw Hill New Delhi.
4. Structural Analysis: *Kassimali*, TWS Publications.
5. Element of Structural Analysis: *Norris and Wilbur*, McGraw Hill.
6. Structural Analysis: *Laursen H.I*, McGraw Hill Publishing Co.
7. Structural theorem and their application: *B.G. Neal*, Pergaman Press.
8. Fundamentals of Structural Analysis: *K.M. Leet*, C.M. Uang and A.M. Gilbert, Tata McGraw Hill, New Delhi.
9. Elementary theory of Structures: *Hseih*, Prentice Hall

Semester- IV

Course Code	Course Name	Credits
CEC403	Surveying	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	-	-	-	100

Rationale

As it is always said “well begun is half done”. All civil engineering projects such as buildings, roads, bridges, railways, airports, dams, water treatment plants, sewage treatment plants begin with surveying. Knowledge of surveying is thus fundamental and very useful to all civil engineers. In this course, the students are well informed about the principles and methods of surveying. The students are made conversant with various instruments which are used in the field to take measurements for preparation of drawings. The course introduces the advancements in instruments and methods of surveying. The study deals with the methods of computing land areas and volume of earthworks. The course also covers horizontal and vertical curves.

Objectives

The students will be able to learn:

1. The basic principles and classification of surveying.
2. Various methods of measurements in surveying.
3. The appropriate techniques of surveying and skills of collecting field data for preparing drawings.
4. Advancements in instruments and methods of surveying.
5. The methods of computing areas and volumes using the site specific data for various purposes.
6. The setting out techniques of curves.

Detailed Syllabus

Module	Course Modules/ Contents		Periods
1	Introduction		5
	1.1	Definition, principles, objectives, fundamental classification-plane and geodetic.	
	1.2	Chaining, Ranging and offsetting: Definitions, Principles, Instruments required, Obstacles, conventional signs and symbols.	
	1.3	Bearings – Different types, compass – prismatic, surveyor, dip, declination and local attraction, compass traversing	
2	Levelling and Contouring		8
	2.1	Definitions, basic terms, types of instruments-dumpy level and Auto level, principal axes of dumpy level, temporary and permanent adjustments	
	2.2	Booking and reduction of levels, plane of collimation (HI) and rise-fall methods, computation of missing data, distance to the visible horizon, corrections due to curvature and refraction, reciprocal levelling, Numerical problems	
	2.3	Differential levelling, profile levelling, fly levelling, check levelling, precise levelling, sources of errors, difficulties in levelling work, corrections and precautions work in levelling	
	2.4	Contouring: terms, contour, contouring, contour interval, horizontal equivalent Direct and indirect methods of contouring, interpolation of contours, uses of Contours and characteristics of contour lines. Grade contour	
3	Theodolite Surveying		8
	3.1	Various parts and axes of transit, technical terms, temporary and permanent adjustments of a transit, measurement of horizontal and vertical angles, Methods of repetition and reiteration.	
	3.2	Different methods of running a theodolite traverse, Latitudes and departures, rectangular coordinates, traverse adjustments by Bowditch's, transit and Modified transit rules, Gales Traverse Table, Numerical Problems.	
	3.3	Miscellaneous use of theodolite for various works such as prolongation of a straight line, setting out an angle, bearing measurements. Omitted measurements, Problems in using theodolite traversing, errors in theodolite traversing.	
4	Indirect and Advanced Methods of Measurement		7
	4.1	Tacheometry-Principle, Objective, Suitability and different methods of tacheometry, Stadia formula, Radial contouring, numerical on stadia method only	
	4.2	Electronic Distance Measurement: Working Principles, types, applications in surveying	
		Total Station- Working Principles, applications in surveying	
	4.3	Introduction to GPS	
	Plane Table Surveying, Areas and Volumes		5

5	5.1	Definition, principle, accessories required for plane table surveying, merits and demerits, temporary adjustments, Different methods of plane table surveying	
	5.2	Areas: Area of an irregular figure by trapezoidal rule, average ordinate rule, Simpson's 1/3 rule, various coordinate methods. Planimeter: types including digital planimeter, area of zero circle, uses of planimeter.	
	5.3	Volumes: Computation of volume by trapezoidal and prismoidal formula, volume from spot levels, volume from contour plans.	
6	Curves		6
	6.1	Horizontal Curves-Definitions of different terms, necessity and types of curves. Methods of setting out Simple circular curves- linear methods and Angular methods (Numericals on simple circular curves only)	
	6.2	Vertical curves– Definitions, geometry and types. Tangent correction and chord gradient methods.	
Total			39

Contribution to Outcomes

After completion of the course, the learner will be able to:

1. Apply the principles of surveying and field procedures to conduct the various surveys
2. Use various methods for taking linear and angular measurements
3. Collect, record and analyse the field data for preparing drawings.
4. Explain the advancements in instruments and methods
5. Calculate the area of land and volume of earthwork
6. Set out curves

Internal Assessment (20 marks):

Consisting **Two Compulsory Class Tests:**

First test based on approximately 40% of the contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum

1. The question paper will consist of **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should cover **maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature**(for example if Q.2 has part (a) from module 3 then part (b) will be from any other module other than module 3)
4. Only **Four questions need to be solved.**

Recommended Books:

1. Surveying and Levelling: R. Agor, Vol. -I, 11th Edition, Khanna Publishers (ISBN8174092358)

2. Surveying and Levelling: Kanetkar and Kulkarni, Vol. -I, 24th Edition, Pune Vidyarthi Griha, Pune. (ISBN 8185825114)
3. Surveying and Levelling: Dr. B.C. Punmia, Vol.-I, 16th Edition, Vol. -II 4th Edition, Laxmi Publications (ISBN 9788170088530)
4. Surveying and Levelling: N N Basak, 2nd Edition, Tata McGraw Hill, New Delhi. (ISBN 9789332901537)

Reference Books:

1. Surveying: Volume -I: Dr K.R. Arora, Standard Book House.
2. Surveying and Levelling (2nd Edition): R. Subramanian; Oxford Higher Education.
3. Surveying and Levelling (Vol.-I): S.K. Duggal, Tata McGraw Hill
4. Textbook of Surveying, C Venkatramaiah, University Press, Hyderabad, Latest Edition
5. Fundamentals of Surveying, S.K. Roy, Prentice Hall India, New Delhi
6. Surveying for Engineers, John Uraire and Bill Price, Palgrave Macmillan
7. Surveying: Theory and Practice, James Anderson, Edward M. Mikhail, Tata McGraw Hill

Semester - IV

Course Code	Course Name	Credits
CEC 404	Building Materials & Concrete Technology	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03		-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 Hrs	--	--	---	100

Rationale

Materials are essential elements, constituent parts (or) substances which are used to raise a building, but materials could not be turned into structures without a method of construction. This course provides necessary knowledge about properties, uses of different types of building materials and the selection of materials, its mix proportioning, mixing, placing, compacting and curing. This course is intended for gaining useful knowledge with respect to facts, concepts, principles and procedures related to building materials and concrete technology so that student can effectively execute quality control during building construction work.

Objectives

1. To identify the good and significant materials to be used for the construction work and their associated quality, durability, warranties, and availability.
2. To study the manufacturing process, properties and use of different types of building materials like stone, brick, glass, timber and the materials such as paints and varnishes used for the treatment of surfaces so as to achieve good knowledge about the building materials.
3. To acquire a thorough knowledge about the properties and significance of different materials used for the manufacturing of concrete.
4. To study the properties, test conducted and significance of concrete in terms of properties of fresh and hardened concrete.
5. To understand the concept and optimization of mix design of concrete for different exposure conditions.
6. To enable the students to understand the mechanized and precise procedure of concrete production in Ready Mix Plants. To understand the basic non-destructive tests conducted on concrete to check the in place strength and durability of concrete.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1		Introduction to building materials and concrete:	03
	1.1	Introduction to building materials: Introduction, role of materials in construction, classification of materials, economical and durable materials.	
	1.2	Introduction to concrete: History of concrete, necessity, limitations, merits and demerits.	
2		Building Materials:	09
	2.1	Stones: Classification and properties of building stones, relation to their structural requirements, quarrying, dressing, seasoning and preservative treatments.	
	2.2	Bricks and blocks: Burnt clay bricks: raw materials, manufacturing processes, classification, properties, defects, tests as per BIS codes. Bricks for special use: refractory bricks. Concrete blocks, Paver block, Autoclaved Aerated Concrete (AAC) blocks, Cellular Light Weight Concrete (CLC) blocks and ceramic tiles: raw materials, manufacturing process and properties.	
	2.3	Glass: Properties, types, uses.	
	2.4	Timber: Types of natural wood and artificial wood, preservative treatments, defects in timber, wood products and wood composites.	
	2.5	Damp proofing, water proofing materials and Termite proofing.	
	2.6	Mortar: Types, ingredients, proportions and suitability.	
	2.7	Paints, Enamels and Varnishes: Composition. Painting on: plastered surfaces, wood surfaces, metal surfaces. Effect of weather on: Enamels, distemper, white wash and colour wash, varnish, French polish, Wax Polish.	
	2.8	Miscellaneous Materials: Gypsum, Plaster of Paris, Heat and sound insulating materials.	
3		Constituent of Concrete:	09
	3.1	Fine and Coarse Aggregates: Classification, physical and mechanical properties and their influence on the properties of concrete, gradation, Alkali aggregate reaction. Properties of manufacturing sand.	
	3.2	Cement (OPC): Grades, Manufacturing, Chemical composition, Hydration of cement, Physical properties as per BIS code. Effects of chemical constituents on the properties of cement. Different types of cement: Chemical composition, properties as per relevant IS codes and their applications.	
	3.3	Water: Desired quality of water for concrete.	
	3.4	Lime: Types and their usages.	
	3.5	Admixtures: Definition and purposes, types of mineral and	

		chemical admixtures. Test on admixtures: chemistry and compatibility with concrete.	
4	Concrete:		06
	4.1	Grades, manufacturing process, preparation of batch report, Duff Abram's W/C ratio law & its significance.	
	4.2	Properties of fresh and hardened concrete, factors affecting of workability, vibration of concrete, Types of vibrators: Internal, external, surface and table vibrators.	
	4.3	Durability: factors affecting durability, relation between durability and permeability, laboratory tests on durability such as Permeability test, Rapid chloride penetration test (RCPT).	
5	Concrete Mix Design:		08
	5.1	Definition and objectives, Types of mix as per IS:456, Mix design for compressive strength and flexural strength in accordance with IS 10262 and IS 456.	
	5.2	Methods of Curing of concrete, Methods of determining compressive Strength of accelerated-cured concrete test specimens as per IS 9013, Calculation of ingredients of concrete for batching as per concrete mix proportions for different grades.	
6	Concreting Methods and Test		04
	6.1	Ready Mixed Concrete: Advantages of RMC, Components and Lay-out of RMC plant. Distribution and Transport, Handling and Placing. Codes recommendations.	
	6.2	Non-Destructive Testing: Need, application and limitation, Schmidt Rebound hammer test, Ultrasonic Pulse Velocity test.	

Contribution to Outcome

On completion of this course, the students will be able to:

1. To develop and implement the conceptual knowledge of building materials in the construction industry.
2. Assess the properties of building stones and their classifications. Understand the concept of various methods of manufacturing of bricks and different types of concrete blocks.
3. To expose students to various quality control aspects of civil engineering materials by performing different lab tests on materials.
4. Identify the ingredients and properties of fresh and hardened concrete.
5. To interpret and design concrete mix for various grades for various exposure conditions.
6. To study the new technology for manufacturing, testing and quality of concrete.

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I).

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be compulsory and should cover **maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only **Four questions need to be solved.**

Recommended Books:

1. A Building Construction: *S.C. Rangwala*, Charotar Publications, Gujarat, India.
2. Building Construction: *S.P. Arora, Dr.S.P. Bindra*, Dhanpat Rai Publication, New Delhi.
3. Building Construction: *Dr. B.C. Punmia, A.K.Jain, A.R.Jain*, Laxmi Publication., New Delhi.
4. Concrete Technology Theory and Practice: *M.S. Shetty*, S.Chand Publication.
5. Concrete Technology: *M.L. Gambhir*, Tata McGraw Hill, New Delhi.
6. Concrete Technology: *A.M. Neville & J. J. Brooks.*, ELBS-Longman.
7. Concrete Technology: *A.M. Neville & Isaac Pitman*, London.
8. Concrete Technology: *A. R. Shanthakumar*, Oxford University Press.
9. Materials of Construction: *D. N. Ghose*, Tata McGraw Hill, Delhi.
10. Building Materials: *S.K. Duggal*, New Age International Publishers.
11. Concrete Technology: *D. F. Orchard*, Wiley, 1962.
12. Relevant codes: BIS, ACI & BS.

Reference Books/Reference Materials:

1. Engineering Materials: *S.R. Rangwala*, Charotar Publications.
2. Architectural Materials science: *D. Anapetor*, Mir Publishers.
3. Introduction to Engineering Materials: *B. K. Agrawal*, Tata McGraw Hill, New Delhi.
4. Engineering Materials: *P. Surendra Singh*, Vani Education Books, New Delhi.
5. Building Materials (Products, Properties and Systems): *M.L. Gambhir and NehaJamwal*, McGraw Hill Publications.
6. Properties of concrete: *Neville, Isaac Pitman*, London.
7. NPTEL Lecture series on Building Materials and Concrete Technology.

Semester- IV

Course Code	Course Name	Credits
CEC405	Fluid Mechanics - II	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	-	-	-	100

Rationale

The course introduces the fluid flow science, problems and their applications in varied conditions. The study deals with the characteristics of fluid flow in pipes namely compressible, laminar and turbulent with their applications in detail.

Objectives

The students will be able to learn:

1. The knowledge of closed conduit flows, determine various losses through pipes, Pipe network and Water hammer effect
2. Theory of Laminar flow and Turbulent flow,
3. Understand the concept of Boundary Layer theory, flow separation and forces around submerged bodies
4. Application of moment of momentum principle on pipe bends and sprinklers
5. The importance of dimensionless numbers, dimensional analysis and similarities.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1		Flow through pipes	14
	1.1	Flow through pipes: Loss of head through pipes, Darcy-Weisbach equation, Major and minor losses. Hydraulic gradient line and Total energy gradient line, pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flow through Branched pipes, three reservoir problem, siphon.	
	1.2	Pipe network and water hammer: Hardy cross method, water hammer in Pipes-Gradual closure and instantaneous closure of valve control measures	

	1.3	Flow through nozzles: Power transmitted through nozzle, condition for maximum power transmitted,diameter of nozzle for maximum transmission of power	
2	Laminar Flow		05
	Reynolds experiment, critical velocity, laminar flow through circular pipes, flow between two parallel plates: stationary and moving.		
3	Turbulent Flow		04
	Causes of turbulence, shear stress in turbulent flow, Reynolds's stresses, Prandtl's mixing length Theory, Hydro dynamically smooth and rough boundaries, velocity distribution in smooth and rough pipes, Karman-Prandtl's velocity distribution equation.		
4	Boundary Layer Theory		07
	Development of boundary layer over flat surfaces. Boundary layer thickness, energy thickness and momentum thickness, Boundary layer separation and control. Introduction to flow around submerged body, drag and lift, terminal velocity of body, Magnus Effect.		
5	Dynamics of Fluid Flow		04
	Momentum principle, Moment of momentum principle (applications: Pipe bends and sprinklers).		
6	Dimensional Analysis		05
	Dimensional homogeneity, Buckingham's π theorem, Rayleigh's method, dimensionless numbers and their significance, Model (or similarity) laws, application of model laws: Reynolds's model law, Froude's model law, Euler's Model law, Weber's Model law, Mach model law, scale effect in models.		
Total			39

Contribution to Outcome

Upon completion of the course, students shall have ability to:

1. Analyze flow through pipes, various losses through pipes, pipe network and power transmission through nozzle
2. Explain the concept of Laminar flow and velocity distribution through parallel plates and pipes
3. Explain the concept of Turbulent flow and velocity distribution in pipes
4. Describe boundary layer concept, boundary layer separation and flow around submerged bodies
5. Apply Moment of Momentum Principle

6. Explain the importance of dimensionless numbers, dimensional analysis and similarity behavior of model and prototype

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests:**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

Recommended Books:

1. Hydraulics and Fluid mechanics: Dr P.M. Modi and Dr. S.M. Seth, Standard book House, Delhi
2. Theory and Application of Fluid Mechanics: K. Subramanya, Tata McGraw hill publishing company
3. Fluid Mechanics: Dr. A.K Jain, Khanna Publishers.
4. Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
5. Fluid Mechanics and Hydraulics: Dr. S. K. Ukurande, Ane Books Pvt. Ltd. (Revised Edition, 2012), ISBN97893 8116 2538
6. Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.
7. Fluid Mechanics and Machinery: C.S.P.Ojha, R. Berndtsson and P.N. Chandramouli. Oxford Higher Education.

Reference Books:

1. Fluid Mechanics: Frank M. White, Tata Mc-Graw-Hill International edition.
2. Fluid Mechanics: Streeter White Bed ford, Tata McGraw International edition.
3. Fluid Mechanics with engineering applications: R.L. Daugherty, J.B.Franzini, E.J., Finnemore, Tata McGraw Hill New Delhi.
4. Hydraulics: James F. Cruise, Vijay P. Singh and Mohsen M. Sherif, CENGAGE Learning India Pvt. Ltd., Delhi.

Semester- IV

Course Code			Course Name			Credits
CEL401			Structural Analysis Tutorial			01
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Objectives:

1. To analyse for axial force in the Coplanar, perfect trusses and analysis of 3- Hinged arches.
2. To study the concept of Influence Line Diagrams and rolling loads.
3. To learn methods for evaluating rotation and displacement of frames and trusses.
4. To analyse the indeterminate structures using Flexibility methods and Stiffness methods.
5. To understand Plastic analysis.

Outcomes:

On completion of this course, the students will be able to:

1. Calculate axial forces in the Coplanar trusses by using Method of joints and method of sections and also calculate radial shear, normal thrust and bending moment in parabolic 3-Hinged arches.
2. Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them..
3. Evaluate rotation and displacement at a joint of frames and deflection at any joint of truss and will be able to compute static and kinematic indeterminacy of structure.
4. Analyse the indeterminate structures such as beams & simple rigid jointed frames using Flexibility methods and direct stiffness method.

List of Tutorials and Assignments		
Week (Activity)	Content	Hours
1 st week (Tutorial)	Analysis of Trusses and Three hinged elastic arches (Numericals based on this Module will be solved in tutorial room.)	2

2 nd week (Assignments)	1) Analysis of Trusses and Three hinged elastic arches 2) Solve set of questions given by the course instructor or 3) Write a report on use of arches in civil engineering or 4) Difference in behaviour of trusses and arches if used in bridges or 5) Write a report on limitations of trusses /arches or 6) Report Famous Truss structures / arch structures in world or 7) 6 Write a report on use of trusses in Civil Engineering	2
3 rd week (Tutorial)	Influence line diagrams and rolling loads (Numericals based on this Module will be solved in tutorial room.)	2
4 th week (Assignments)	Influence line diagrams and rolling loads 1) Solve set of questions given by the course instructor or 2) Write a report on use of arches in civil engineering or 3) Design an experiment for ILD of reactions of beam. or 4) Design an experiment for ILD of axial forces of a multi-bay truss. or 5) write a report on IRC and classes of rolling loads	2
5 th week (Tutorial)	Determinate and Indeterminate structure (Numericals based on this Module will be solved in tutorial room.)	2
6 th week (Assignments)	Determinate and Indeterminate structure 1) Solve set of questions given by the course instructor or 2) Prepare a chart explaining static and kinematic indeterminacy or 3) Write a computer program in C++ or MS-excel or similar for ILD of reactions. or 4) Write a computer program in C++ or MS-excel or similar for ILD for axial forces in Truss members.	2
7 th week (Tutorial)	Analysis of indeterminate structures by Flexibility method (Numerical based on this Module will be solved in tutorial room.)	2
8 th week (Assignments)	Analysis of indeterminate structures by Flexibility method 1) Solve set of questions given by the course instructor or 2) Prepare a poster on Flexibility and Stiffness approach or 3) Solve a set of 4-5 questions given by the course instructor on Flexibility methods and validate the same using relevant Structural Analysis or design software.	2
9 th week (Tutorial)	Analysis of indeterminate structures by Direct stiffness method (Numericals based on this Module will be solved in tutorial room).	2
10 th week (Assignments)	Analysis of indeterminate structures by Direct stiffness method 1) Solve set of questions given by the course instructor or 2) Write a report on Stiffness methods in civil engineering or 3) Prepare a poster on Clapeyron's theorem for continuous beam.or 4) Solve a set of 4-5 questions given by the course instructor on Direct stiffness method and validate the same using relevant Structural Analysis or design software.	2

11 th week (Tutorial)	Moment distribution method, Plastic analysis of structures (Numerical based on this Module will be solved in tutorial room.)	2
12 th week (Assignments)	Moment distribution method, Plastic analysis of structures 1) Solve set of questions given by the course instructor or 2) Write a report on Plastic analysis of structures or 3) Solve a set of 4-5 questions given by the course instructor on Moment distribution method and validate the same using relevant Structural Analysis or design software.	2
13 th week	Viva-Voce Examination	2

- **Assessment:**

Term Work: Term work will include Tutorial work and Assignments both, Distribution of marks for Term Work shall be as follows:

Tutorial work- : 15 Marks
Assignments- : 10 Marks
Total Term work : 25 Marks
Attendance : Apply multiplying Factor 0.5 to 1.0 to the above total.

End Semester Oral Examination

Oral examination will be based on entire syllabus.

Semester- IV

Course Code	Course Name	Credits
CEL402	Surveying(Lab)	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	50	-	25	75

@ For the course “Surveying (Lab)” the oral examination shall be conducted in conjunction with the practical conduction.

Course Objectives:

The students will be able to learn:

- 1) Various surveying instruments, their least counts, various parts and suitable uses.
- 2) Methods of measurements in the field.
- 3) Skills for collecting, recording and analysing the field data.
- 4) Advanced instruments and methods.
- 5) First hand practical experience by receiving field exposure to collect site specific data.
- 6) Setting out techniques.

Course Outcomes:

At the end of the course, learner will be able to:

- 1) Operate and use the surveying instruments according to the accuracy and suitability.
- 2) Measure linear and angular dimensions in horizontal and vertical planes.
- 3) Collect, record and analyse the field data systematically.
- 4) Prepare plans of the existing features on the ground, sections and contours.
- 5) Compute the area of land and the volume of earthwork.
- 6) Set out curves and foundation plans.

List of practical's and projects:

Perform minimum **six** practical's out of 01 to 10 and all the projects are **mandatory**

Module	Detailed Contents	Lab Sessions/Hr
1	Chain and cross staff surveying.	03 hrs
2	Measuring bearings of a closed traverse with prismatic compass and computation of interior angles.	03 hrs
3	Simple and compound levelling	03 hrs
4	Measurement of horizontal and vertical angles.	03 hrs
5	Finding constants, heights and distances using tachometry.	03 hrs
6	Measurement of distances, bearings and area using total station.	03 hrs
7	Plane Table Surveying by intersection method.	03 hrs
8	Find an area of irregular figure using a conventional planimeter and verify it using a digital planimeter.	03 hrs
9	Setting out a simple curve by Rankine's method.	03 hrs
10	Setting out a simple foundation plan.	03 hrs
Projects		
A survey camp of three days is to be arranged to execute the following projects for undergoing the students through practical instructions in civil engineer's career with the actual field exposure at an ideal site location .		
1	Project I: Road project using Auto level for a minimum length of 500 m including fixing of alignment, profile levelling, cross-sectioning at 20m interval,, plotting of 'L' section and 'C' section. (Two full imperial sheets, the first sheet with key plan and 'L' section and the second sheet covering any three typical Cross-sections)	
2	Project II: Block Contouring project using Auto level for minimum 60 m × 60 m area and generating contours by MS Excel. (Take contour interval as 0.2 meter)	
3	Project III: Tachometric contouring project on a hilly area with at least two instrument stations about 60 m to 100 m apart and generating contours by taking contour intervals as 1 meter.	

Assessment:

Teamwork

Including above practical work, projects and assignments, distribution of marks for Term Work shall be as follows:

Practical Work-	:	15 marks
Assignments -	:	05 marks
Attendance-	:	05 marks
Projects-		
Field work	:	15marks
Office work (Drawings)	:	10marks
Total	:	50marks

- **End Semester Practical/ Oral Examination**

Practical Examination : 10 Marks

Oral Examination : 15 Marks.

Oral examination will be conducted after conduction of practical examination & it will be based on term work & Practical examination

Reference Books:

- 1) Surveying and Levelling : *R. Agor, Vol-I, 11th Edition*, Khanna Publishers (ISBN 8174092358)
- 2) Surveying and Levelling : *Kanetkar and Kulkarni, Vol-I, 24th Edition*, Pune Vidyarthi Griha, Pune. (ISBN 8185825114)
- 3) Surveying and Levelling : *Dr. B.C. Punmia*, Vol.-I, 16th Edition, Vol -II 4th Edition, Laxmi Publications (ISBN 9788170088530)
- 4) Surveying and Levelling: *N N Basak*, 2nd Edition, Tata McGraw Hill, New Delhi. (ISBN 9789332901537)
- 5) Surveying: Vol-I: Dr K.R. Arora, Standard Book House.
- 6) Surveying and Levelling (2nd Edition): R. Subramanian; Oxford Higher Education.
- 7) Surveying and Levelling (Vol.-I): S.K. Duggal, Tata Mc-Graw Hill

Semester- IV

Course Code	Course Name	Credits
CEL 403	Building Materials & Concrete Technology (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Objectives:

- 1) To determine physical and mechanical properties of materials used in the manufacturing of concrete like cement and aggregates.
- 2) To test the physical attributes and mechanical strength of burnt clay bricks used in the construction of structures.
- 3) To determine the various properties of fresh and hardened concrete with and without the addition of admixtures.
- 4) To study the different basic non-destructive tests conducted in the laboratory or on site to determine the durability and strength of existing concrete structures.
- 5) To utilize the knowledge of mix design in the manufacturing of concrete, in the laboratory.
- 6) To test the physical attributes and mechanical strength of timber and tiles used in the construction of various components of the structure.
- 7) To understand the practical scenario of the commonly used building materials in terms of their availability, cost and significance through market surveys.

Outcomes: Learner will be able to...

- 1) Develop collaborative skills to work in a team/group
- 2) Test physical properties of cement, aggregates and concrete.
- 3) Test various other building materials like tiles, bricks and timber
- 4) Evaluate the effects of admixtures on physical properties of concrete.
- 5) Design the concrete mix.
- 6) To bridge the gap between theoretical and market/industrial practices by market surveys.

List of Experiments (first seven are compulsory)

Module	Detailed Contents	Lab Sessions/Hr
1	Physical properties of OPC: Physical test, Fineness, Standard consistency, Soundness, Setting time, Compressive strength.	02/04
2	Physical Properties of Fine and Course Aggregates: Specific gravity, bulk density, Moisture content, Water absorption, flakiness index, elongation index, Fineness modulus, Silt content and bulking of sand	02/04
3	Tests on burnt clay bricks	01/02
4	Effect of w/c ratio on workability (slump cone, compaction factor, V-B test, flow table) and strength of concrete	02/04
5	Study of admixtures and their effect on workability and strength of concrete.	01/02
6	Non-destructive testing of concrete: Rebound hammer and ultrasonic pulse velocity	01/02
7	Concrete mix design in the laboratory	01/02
8	Test on tiles(optional)	01/02
9	Compression test on timber (Parallel/ perpendicular to the grains). (optional)	01/02
10	Market survey on common building materials (optional)	01/02

Site Visit/ Industrial Visit:

The students shall visit the brick, paver blocks, concrete block, cement, glass and RMC industrial plants. They shall prepare a report of the visit and the same shall be evaluated by the concerned teacher.

Assessment:

The term work shall consist of:

- Report of experiments performed.
- Industrial visit report to at least **any one** of the above mentioned industrial plants.
- Although minimum numbers of market surveys and industrial visits are prescribed, the students shall be encouraged to perform more number of experiments and site/ industrial visits.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work including industrial/ site visit report. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Individual Practical performance	:	07 Marks
Assignments	:	03 Marks
Reports of experiment	:	05 Marks

Site Visit/Industrial visit	:	05 Marks
Attendance	:	05 Marks
Total	:	25 marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to
75% - 80%: 03 Marks; 81% - 90%: 04 Marks; 91% onwards: 05 Marks.

End Semester Practical/Oral Examination

The oral examination shall be based on the entire syllabus and term work comprising of the report of the experiments/ practical conducted by the students and a detail report of the industrial/ site visit.

Recommended Books:

- 1) A Building Construction: S.C. Rangwala, Charotar Publications, Gujarat, India.
- 2) Building Construction: S.P. Arora, Dr.S.P. Bindra, Dhanpat Rai Publication, New Delhi.
- 3) Building Construction: Dr. B.C. Punmia, A.K.Jain, A.R.Jain, Laxmi Publication., New Delhi.
- 4) Concrete Technology Theory and Practice: M.S. Shetty, S.Chand Publication.
- 5) Concrete Technology: M.L. Gambhir, Tata McGraw Hill, New Delhi.
- 6) Concrete Technology: A.M. Neville & J. J. Brooks., ELBS-Longman.
- 7) Concrete Technology: A.M. Neville & Isaac Pitman, London.
- 8) Concrete Technology: A. R. Shanthakumar, Oxford University Press.
- 9) Materials of Construction: D. N. Ghose, Tata McGraw Hill, Delhi.
- 10) Building Materials: S.K. Duggal, New Age International Publishers.
- 11) Concrete Technology: D. F. Orchard, Wiley, 1962.
- 12) Relevant codes: BIS, ACI & BS.

Reference Books/Reference Materials:

- 1) Engineering Materials: S.R. Rangwala, Charotar Publications.
- 2) Architectural Materials science: D. Anapetor, Mir Publishers.
- 3) Introduction to Engineering Materials: B. K. Agrawal, Tata McGraw Hill, New Delhi.
- 4) Engineering Materials: P. Surendra Singh, Vani Education Books, New Delhi.
- 5) Building Materials (Products, Properties and Systems): M.L. Gambhir and Neha Jamwal, McGraw Hill Publications.
- 6) Properties of concrete: Neville, Isaac Pitman, London.
- 7) NPTEL Lecture series on Building Materials and Concrete Technology.

Semester- IV

Course Code	Course Name	Credits
CEL404	Fluid Mechanics – II (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

The students will be able to learn:

- 1) to verify the basic fluid mechanics concepts experimentally
- 2) the fluid flow pattern in pipes
- 3) to estimate the losses in pipe flow
- 4) the velocity distribution in pipes

Course Outcomes:

At the end of the course, learner will be able to:

- 1) Verify the Reynold's experiment
- 2) Estimate the viscosity of fluid
- 3) Calculate the losses in pipes
- 4) Assess the flow pattern and velocity distribution in pipe flow
- 5) learn the water hammer phenomenon through demonstration
- 6) learn the wind tunnel testing through demonstration

List of Experiments (Minimum Six)

Module	Detailed Contents	Lab Sessions/Hr
1	Study of different types of flow using Reynold's apparatus	02 hrs
2	Determination of viscosity of fluid	02 hrs
3	Estimation of the head loss due to friction incurred by a fluid along a pipeline (To find the friction factor for the given pipes of different sizes)	04 hrs
4	To determine different losses in pipe fittings (Estimation of the minor losses)	04 hrs
5	Laminar flow through pipes	02 hrs
6	Velocity distribution in circular pipes	04 hrs
7	Turbulent flow through pipe	02 hrs
8	Study of Water Hammer phenomenon	04 hrs
9	Study of wind tunnel	02 hrs

Assessment:

● **Term Work**

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory work-	:	15 Marks
Assignments-	:	05 Marks
Attendance	:	05 Marks

● **End Semester Oral Examination**

Reference Books:

- 1) Fluid Mechanics and Hydraulic Machines: R. K. Rajput, S. Chand and Company
- 2) Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi
- 3) Hydraulics Fluid Mechanics and Fluid Machines: S. Ramamrutham, DhanpatRai Publishing Company (P) Ltd-New Delhi
- 4) Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
- 5) Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
- 6) Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
- 7) Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

Semester- IV

Course Code	Course Name	Credits
CEL405	Skill Based Lab Course-II Total Station and Geographical Information System	1

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	2	-	-	1	-	1

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	50	-	-	50

Objectives:

- 1) To enable the learners, operate the Total Station and generate its output in terms of plans, elevations and 3D views
- 2) To enable the learners, operate the Global Navigation Satellite System (GNSS) receivers and retrieve the information
- 3) To enable the learners work on a Geographical Information System (GIS) platform for assimilating geographical data

Outcomes: Learner will be able to...

- 1) Operate a Total Station and traverse the field
- 2) Perform various operations like computing height of a structure, computing area of plot, subdividing area, demarcating boundaries, etc. Using Total Station
- 3) Set out foundation plan using Total Station
- 4) Compute the point, line and area features using Global Navigation Satellite System
- 5) Plot various existing features in a geographic area on a GIS platform
- 6) Add attribute and perform various statistical operations in GIS

List of Experiments (Minimum Eight)

Module	Detailed Contents	Lab Sessions/Hr
1	Introduction to concepts, fundamental features and working principal of Total Station (TS)	02
2	Temporary settings of a TS in field and perform basic functions on	02

	total station like traversing, area of open plot, height calculations, etc.	
3	Collect detailed features of a plot (comprising features such as 2-3 buildings, courtyards, security cabins, playgrounds, trees, gates, poles, roads, drainage lines, etc.) using TS	04
4	Transfer data collected through TS on a convenient computer aided drafting (CAD) software	02
5	Feeding a CAD plan in TS and setting out a foundation plan using TS	02
6	Introduction to fundamental features of Global Navigation Satellite System (GNSS) and collect point, line and polygon features through a GNSS receiver	02
7	Computing latitudes, longitudes, altitudes of points, length of roads, area of plots, etc. using a GNSS system	02
8	Basic introduction to compatibilities, utilities and attributes of peculiar Geographical Information System (GIS) softwares available in market w.r.t their various commands, features, capabilities and functions.	02
9	Collecting ground points through GNSS and TS for integrating it with spatial data obtained from a GIS platform like google earth, openstreetnetwork, etc. and developing a model on a GIS software	04
10	Add various layers in term of attributes and perform various statistical operations and queries in GIS	04

Assessment:

● Term Work

Including Laboratory Work comprising of minimum 8 software generated sheets distribution of marks for Term Work shall be as follows:

Laboratory work : 40 Marks (comprising of min 8 software generated sheets:
4 using TS and GNSS data in CADD tool and 4 using GIS tool)

Attendance : 10 Marks

Semester- IV

Course Code	Course Name	Credits
CEM 401	Mini Project -1B	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Objectives

- 1) To acquaint with the process of identifying the needs and converting it into the problem.
- 2) To familiarize the process of solving the problem in a group.
- 3) To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
- 4) To inculcate the process of self-learning and research.

Outcome: Learner will be able to...

- 1) Identify problems based on societal /research needs.
- 2) Apply Knowledge and skill to solve societal problems in a group.
- 3) Develop interpersonal skills to work as member of a group or leader.
- 4) Draw the proper inferences from available results through theoretical/experimental/simulations.
- 5) Analyse the impact of solutions in societal and environmental context for sustainable development.
- 6) Use standard norms of engineering practices
- 7) Excel in written and oral communication.
- 8) Demonstrate capabilities of self-learning in a group, which leads to life long learning.
- 9) Demonstrate project management principles during project work.

Guidelines for Mini Project

- 1) Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- 2) Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- 3) Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- 4) A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- 5) Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- 6) Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- 7) Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- 8) The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- 9) With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- 10) However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
 - Marks awarded by guide/supervisor based on log book : 10
 - Marks awarded by review committee : 10
 - Quality of Project report : 05
 -

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
- First shall be for finalisation of problem
- Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
- First review is based on readiness of building working prototype to be conducted.

- Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
 - Identification of need/problem
 - Proposed final solution
 - Procurement of components/systems
 - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
 - First shall be for finalisation of problem and proposed solution
 - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

- 1) Quality of survey/ need identification
- 2) Clarity of Problem definition based on need.
- 3) Innovativeness in solutions
- 4) Feasibility of proposed problem solutions and selection of best solution
- 5) Cost effectiveness
- 6) Societal impact
- 7) Innovativeness
- 8) Cost effectiveness and Societal impact
- 9) Full functioning of working model as per stated requirements
- 10) Effective use of skill sets
- 11) Effective use of standard engineering norms
- 12) Contribution of an individual's as member or leader
- 13) Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

- 1) Quality of problem and Clarity
- 2) Innovativeness in solutions
- 3) Cost effectiveness and Societal impact
- 4) Full functioning of working model as per stated requirements
- 5) Effective use of skill sets
- 6) Effective use of standard engineering norms
- 7) Contribution of an individual's as member or leader
- 8) Clarity in written and oral communication

UNIVERSITY OF MUMBAI



Bachelor of Engineering

in

Computer Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

UNIVERSITY OF MUMBAI**Syllabus for Approval**

Date

Sr. No.	Heading	Particulars
1	Title of the Course	Second Year B.E. Computer Engineering
2	Eligibility for Admission	After Passing First Year Engineering as per the Ordinance 0.6242
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	Ordinance 0.6242
5	No. of Years / Semesters	8 semesters
6	Level	P.G. / U.G. / ~~Diploma~~ / Certificate (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / Semester (Strike out which is not applicable)
8	Status	New / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	With effect from Academic Year: 2020-2021

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface by Board of Studies in Computer Engineering

Dear Students and Teachers, we, the members of Board of Studies Computer Engineering, are very happy to present Second Year Computer Engineering syllabus effective from the Academic Year 2020-21 (REV-2019'C' Scheme). We are sure you will find this syllabus interesting and challenging.

Computer Engineering is one of the most sought-after courses amongst engineering students hence there is a continuous requirement of revision of syllabus. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. It is intended to provide a modern, industry-oriented education in Computer Engineering. It aims at producing trained professionals who can successfully acquainted with the demands of the industry worldwide. They obtain skills and experience in up-to-date the knowledge to analysis, design, implementation, validation, and documentation of computer software and systems.

The revised syllabus falls in line with the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of the revised syllabus are:

1. Reduction in credits to 170 is implemented to ensure that students have more time for extracurricular activities, innovations, and research.
2. Introduction of Skill Based Lab and Mini Project to showcase their talent by doing innovative projects that strengthen their profile and increases the chance of employability.
3. Students are encouraged to take up part of course through MOOCs platform SWAYAM

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Board of Studies in Computer Engineering

Prof. Sunil Bhirud : Chairman

Prof. Madhumita Chatterjee : Member

Prof. Sunita Patil : Member

Prof. Leena Raga : Member

Prof. Subhash Shinde : Member

Prof. Meera Narvekar : Member

Prof. Suprtim Biswas : Member

Prof. Sudhir Sawarkar : Member

Prof. Dayanand Ingle : Member

Prof. Satish Ket : Member

Program Structure for Second Year Computer Engineering

UNIVERSITY OF MUMBAI (With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
CSC301	Engineering Mathematics-III	3	--	1*	3	--	1	4	
CSC302	Discrete Structures and Graph Theory	3	--	--	3	--	--	3	
CSC303	Data Structure	3	--	--	3	--	--	3	
CSC304	Digital Logic & Computer Architecture	3	--	--	3	--	--	3	
CSC305	Computer Graphics	3	--	--	3	--	--	3	
CSL301	Data Structure Lab	--	2	--	--	1	--	1	
CSL302	Digital Logic & Computer Architecture Lab	--	2	--	--	1	--	1	
CSL303	Computer Graphics Lab	--	2	--	--	1	--	1	
CSL304	Skill base Lab course: Object Oriented Programming with Java	--	2+2*	--	--	2	--	2	
CSM301	Mini Project – 1 A	--	4 ^{\$}	--	--	2	--	2	
Total		15	14	1	15	07	1	23	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test2	Avg					
CSC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
CSC302	Discrete Structures and Graph Theory	20	20	20	80	3	--	--	100
CSC303	Data Structure	20	20	20	80	3	--	--	100
CSC304	Digital Logic & Computer Architecture	20	20	20	80	3	--	--	100
CSC305	Computer Graphics	20	20	20	80	3	--	--	100
CSL301	Data Structure Lab	--	--	--	--	--	25	25	50
CSL302	Digital Logic & Computer Architecture Lab	--	--	--	--	--	25	--	25
CSL303	Computer Graphics Lab	--	--	--	--	--	25	25	50
CSL304	Skill base Lab course: Object Oriented Programming with Java	--	--	--	--	--	50	25	75
CSM301	Mini Project – 1 A	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	175	100	775

*Should be conducted batch wise and

\$ indicates workload of Learner (Not Faculty), Students can form groups with minimum 2 (Two) and not more than 4 (Four), Faculty Load: 1 hour per week per four groups

Program Structure for Second Year Computer Engineering
UNIVERSITY OF MUMBAI (With Effect from 2020-2021)
Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total	
CSC401	Engineering Mathematics-IV	3	--	1*	3	--	1	4	
CSC402	Analysis of Algorithm	3	--	--	3	--	--	3	
CSC403	Database Management System	3	--	--	3	--	--	3	
CSC404	Operating System	3	--	--	3	--	--	3	
CSC405	Microprocessor	3	--	--	3	--	--	3	
CSL401	Analysis of Algorithm Lab	--	2	--	--	1	--	1	
CSL402	Database Management System Lab	--	2	--	--	1	--	1	
CSL403	Operating System Lab	--	2	--	--	1	--	1	
CSL404	Microprocessor Lab	--	2	--	--	1	--	1	
CSL405	Skill Base Lab Course: Python Programming	--	2*+2	--	--	2	--	2	
CSM401	Mini Project 1-B	--	4 ^{\$}	--	--	2	--	2	
Total		15	16	1	15	7	1	24	
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract & oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
CSC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
CSC402	Analysis of Algorithm	20	20	20	80	3	--	--	100
CSC403	Database Management System	20	20	20	80	3	--	--	100
CSC404	Operating System	20	20	20	80	3	--	--	100
CSC405	Microprocessor	20	20	20	80	3	--	--	100
CSL401	Analysis of Algorithm Lab	--	--	--	--	--	25	25	50
CSL402	Database Management System Lab	--	--	--	--	--	25	25	50
CSL403	Operating System Lab	--	--	--	--	--	25	25	50
CSL404	Microprocessor Lab	--	--	--	--	--	25	--	25
CSL405	Skill Base Lab Course: Python Programming	--	--	--	--	--	25	--	25
CSM401	Mini Project 1-B	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	175	100	775

*Should be conducted batchwise and

\$ indicates workload of Learner (Not Faculty), Students can form groups with minimum 2 (Two) and not more than 4 (Four), Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Credits
CSC301	Engineering Mathematics-III	4

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II

Course Objectives: The course aims:

1	To learn the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2	To understand the concept of Fourier Series, its complex form and enhance the problem-solving skills.
3	To understand the concept of complex variables, C-R equations with applications.
4	To understand the basic techniques of statistics like correlation, regression, and curve fitting for data analysis, Machine learning, and AI.
5	To understand some advanced topics of probability, random variables with their distributions and expectations.

Course Outcomes: On successful completion, of course, learner/student will be able to:

1	Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.
2	Understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
3	Expand the periodic function by using the Fourier series for real-life problems and complex engineering problems.
4	Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic functions.
5	Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning, and AI.
6	Understand the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.

Module	Detailed Contents	Hours
1	Laplace Transform	7
	1.1 Definition of Laplace transform, Condition of Existence of Laplace transform.	
	1.2 Laplace Transform (L) of standard functions like e^{at} , $\sin(at)$, $\cos(at)$, $\sinh(at)$, $\cosh(at)$ and t^n , $n \geq 0$.	
	1.3 Properties of Laplace Transform: Linearity, First Shifting Theorem, Second Shifting Theorem, Change of Scale, Multiplication by t , Division by t , Laplace Transform of derivatives and integrals (Properties without proof).	
	1.4 Evaluation of real improper integrals by using Laplace Transformation.	
	1.5 Self-learning Topics: Laplace Transform: Periodic functions, Heaviside's Unit Step function, Dirac Delta Function, Special functions (Error and Bessel)	
2	Inverse Laplace Transform	7
	2.1 Definition of Inverse Laplace Transform, Linearity property, Inverse Laplace Transform of standard functions, Inverse Laplace transform using derivatives.	
	2.2 Partial fractions method to find Inverse Laplace transform.	
	2.3 Inverse Laplace transform using Convolution theorem (without proof)	
	2.4 Self-learning Topics: Applications to solve initial and boundary value	

		problems involving ordinary differential equations.	
3	Fourier Series:		7
	3.1	Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof).	
	3.2	Fourier series of periodic function with period 2π and $2l$.	
	3.3	Fourier series of even and odd functions.	
	3.4	Half range Sine and Cosine Series.	
	3.5	Self-learning Topics: Orthogonal and orthonormal set of functions, Complex form of Fourier Series, Fourier Transforms.	
4	Complex Variables:		7
	4.1	Function $f(z)$ of complex variable, Limit, Continuity and Differentiability of $f(z)$, Analytic function: Necessary and sufficient conditions for $f(z)$ to be analytic (without proof).	
	4.2	Cauchy-Riemann equations in Cartesian coordinates (without proof).	
	4.3	Milne-Thomson method: Determine analytic function $f(z)$ when real part (u), imaginary part (v) or its combination ($u+v$ / $u-v$) is given.	
	4.4	Harmonic function, Harmonic conjugate and Orthogonal trajectories.	
	4.5	Self-learning Topics: Conformal mapping, Linear and Bilinear mappings, cross ratio, fixed points and standard transformations.	
5	Statistical Techniques		6
	5.1	Karl Pearson's coefficient of correlation (r)	
	5.2	Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks)	
	5.3	Lines of regression	
	5.4	Fitting of first- and second-degree curves.	
	5.5	Self-learning Topics: Covariance, fitting of exponential curve.	
6	Probability		6
	6.1	Definition and basics of probability, conditional probability.	
	6.2	Total Probability theorem and Bayes' theorem.	
	6.3	Discrete and continuous random variable with probability distribution and probability density function.	
	6.4	Expectation, Variance, Moment generating function, Raw and central moments up to 4 th order.	
	6.5	Self-learning Topics: Skewness and Kurtosis of distribution (data).	

References:	
1	Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication.
2	Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited.
3	Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa Publication.
4	Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education.
5	Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill Education.
6	Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series.

Term Work:	
General Instructions:	
1	Batch wise tutorials have to be conducted. The number of students per batch will be as per University pattern for practical.
2	Students must be encouraged to write at least 6 class tutorials on the entire syllabus.
3	A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This will be considered as a mini project in Engineering Mathematics. This project will be graded out of 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows:		
1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment Test:

The assessment consists of two class tests of 20 marks each. The 1st class test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 35% syllabus is completed. The duration of each test will be for one hour.

End Semester Theory Examination:

1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4 sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions, each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours, as mentioned in the syllabus.

Course Code	Course Name	Credits
CSC302	Discrete Structures and Graph Theory	3

Pre-requisite: Basic Mathematics

Course Objectives: The course aims:

1	Cultivate clear thinking and creative problem solving.
2	Thoroughly train in the construction and understanding of mathematical proofs. Exercise common mathematical arguments and proof strategies.
3	To apply graph theory in solving practical problems.
4	Thoroughly prepare for the mathematical aspects of other Computer Engineering courses

Course Outcomes: On successful completion, of course, learner/student will be able to:

1	Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
2	Ability to reason logically.
3	Ability to understand relations, functions, Diagraph and Lattice.
4	Ability to understand and apply concepts of graph theory in solving real world problems.
5	Understand use of groups and codes in Encoding-Decoding
6	Analyze a complex computing problem and apply principles of discrete mathematics to identify solutions

Module	Detailed Contents		Hours
1	Logic		6
	1.1	Propositional Logic, Predicate Logic, Laws of Logic, Quantifiers, Normal Forms, Inference Theory of Predicate Calculus, Mathematical Induction.	
2	Relations and Functions		6
	2.1	Basic concepts of Set Theory	
	2.2	Relations: Definition, Types of Relations, Representation of Relations, Closures of Relations, Warshall's algorithm, Equivalence relations and Equivalence Classes	
	2.3	Functions: Definition, Types of functions, Composition of functions, Identity and Inverse function	
3	Posets and Lattice		5
	3.1	Partial Order Relations, Poset, Hasse Diagram, Chain and Anti chains, Lattice, Types of Lattice, Sub lattice	
4	Counting		6
	4.1	Basic Counting Principle-Sum Rule, Product Rule, Inclusion-Exclusion Principle, Pigeonhole Principle	
	4.2	Recurrence relations, Solving recurrence relations	
5	Algebraic Structures		8
	5.1	Algebraic structures with one binary operation: Semi group, Monoid, Groups, Subgroups, Abelian Group, Cyclic group, Isomorphism	
	5.2	Algebraic structures with two binary operations: Ring	
	5.3	Coding Theory: Coding, binary information and error detection, decoding and error correction	
6	Graph Theory		8
		Types of graphs, Graph Representation, Sub graphs, Operations on Graphs, Walk, Path, Circuit, Connected Graphs, Disconnected Graph, Components, Homomorphism and Isomorphism of Graphs, Euler and Hamiltonian Graphs, Planar Graph, Cut Set, Cut Vertex,	

		Applications.	

Textbooks:

1	Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, “Discrete Mathematical Structures”, Pearson Education.
2	C. L. Liu “Elements of Discrete Mathematics”, second edition 1985, McGraw-Hill Book Company. Reprinted 2000.
3	K. H. Rosen, “Discrete Mathematics and applications”, fifth edition 2003, Tata McGraw Hill Publishing Company

References:

1	Y N Singh, “Discrete Mathematical Structures”, Wiley-India.
2	J. L. Mott, A. Kandel, T. P. Baker, “Discrete Mathematics for Computer Scientists and Mathematicians”, Second Edition 1986, Prentice Hall of India.
3	J. P. Trembley, R. Manohar “Discrete Mathematical Structures with Applications to Computer Science”, Tata McGraw Hill Publishing Company
4	Seymour Lipschutz, Marc Lars Lipson, “Discrete Mathematics” Schaum’s Outline, McGraw Hill Education.
5	Narsing Deo, “Graph Theory with applications to engineering and computer science”, PHI Publications.
6	P. K. Bisht, H. S. Dhami, “Discrete Mathematics”, Oxford press.

Assessment:
Internal Assessment Test:

The assessment consists of two class tests of 20 marks each. The 1st class test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 40% syllabus is completed. The duration of each test will be for one hour.

End Semester Theory Examination:

1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4 sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions, each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours, as mentioned in the syllabus.

Useful Links

1	https://www.edx.org/learn/discrete-mathematics
2	https://www.coursera.org/specializations/discrete-mathematics
3	https://nptel.ac.in/courses/106/106/106106094/
4	https://swayam.gov.in/nd1_noc19_cs67/preview

Course Code	Course Name	Credit
CSC303	Data Structure	03

Pre-requisite: C Programming	
Course Objectives: The course aims:	
1	To understand the need and significance of Data structures as a computer Professional.
2	To teach concept and implementation of linear and Nonlinear data structures.
3	To analyze various data structures and select the appropriate one to solve a specific real-world problem.
4	To introduce various techniques for representation of the data in the real world.
5	To teach various searching techniques.
Course Outcomes:	
1	Students will be able to implement Linear and Non-Linear data structures.
2	Students will be able to handle various operations like searching, insertion, deletion and traversals on various data structures.
3	Students will be able to explain various data structures, related terminologies and its types.
4	Students will be able to choose appropriate data structure and apply it to solve problems in various domains.
5	Students will be able to analyze and Implement appropriate searching techniques for a given problem.
6	Students will be able to demonstrate the ability to analyze, design, apply and use data structures to solve engineering problems and evaluate their solutions.

Module	Detailed Content	Hours
1	Introduction to Data Structures	2
	1.1 Introduction to Data Structures, Concept of ADT, Types of Data Structures-Linear and Nonlinear, Operations on Data Structures.	
2	Stack and Queues	8
	2.1 Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Applications of Stack-Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation, Recursion.	
	2.2 Introduction, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Introduction of Double Ended Queue, Applications of Queue.	
3	Linked List	10
	3.1 Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List, Circular Linked List, Doubly Linked List, Operations on Singly Linked List and Doubly Linked List, Stack and Queue using Singly Linked List, Singly Linked List Application-Polynomial Representation and Addition.	
4	Trees	11
	4.1 Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, Applications of Binary Tree-Expression Tree, Huffman Encoding, Search Trees-AVL, rotations in AVL Tree, operations on AVL Tree, Introduction of B Tree, B+ Tree.	
5	Graphs	4

	5.1	Introduction, Graph Terminologies, Representation of Graph, Graph Traversals-Depth First Search (DFS) and Breadth First Search (BFS), Graph Application-Topological Sorting.	
6		Searching Techniques	4
	6.1	Linear Search, Binary Search, Hashing-Concept, Hash Functions, Collision resolution Techniques	

Textbooks:

1	Aaron M Tenenbaum, Yedidyah Langsam, Moshe J Augenstein, “Data Structures Using C”, Pearson Publication.
2	Reema Thareja, “Data Structures using C”, Oxford Press.
3	Richard F. Gilberg and Behrouz A. Forouzan, “Data Structures: A Pseudocode Approach with C”, 2 nd Edition, CENGAGE Learning.
4	Jean Paul Tremblay, P. G. Sorenson, “Introduction to Data Structure and Its Applications”, McGraw-Hill Higher Education
5	Data Structures Using C, ISRD Group, 2 nd Edition, Tata McGraw-Hill.

References:

1	Prof. P. S. Deshpande, Prof. O. G. Kakde, “C and Data Structures”, DreamTech press.
2	E. Balagurusamy, “Data Structure Using C”, Tata McGraw-Hill Education India.
3	Rajesh K Shukla, “Data Structures using C and C++”, Wiley-India
4	GAV PAI, “Data Structures”, Schaum’s Outlines.
5	Robert Kruse, C. L. Tondo, Bruce Leung, “Data Structures and Program Design in C”, Pearson Edition

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will consist of 6 questions, each carrying 20 marks.
2	The students need to solve a total of 4 questions.
3	Question No.1 will be compulsory and based on the entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links

1	https://nptel.ac.in/courses/106/102/106102064/
2	https://www.coursera.org/specializations/data-structures-algorithms
3	https://www.edx.org/course/data-structures-fundamentals
4	https://swayam.gov.in/nd1_noc19_cs67/preview

Course Code	Course Name	Credit
CSC304	Digital Logic & Computer Organization and Architecture	3

Pre-requisite: Knowledge on number systems

Course Objective:

1	To have the rough understanding of the basic structure and operation of basic digital circuits and digital computer.
2	To discuss in detail arithmetic operations in digital system.
3	To discuss generation of control signals and different ways of communication with I/O devices.
4	To study the hierarchical memory and principles of advanced computing.

Course Outcome:

1	To learn different number systems and basic structure of computer system.
2	To demonstrate the arithmetic algorithms.
3	To understand the basic concepts of digital components and processor organization.
4	To understand the generation of control signals of computer.
5	To demonstrate the memory organization.
6	To describe the concepts of parallel processing and different Buses.

Module	Detailed Content	Hours
1	Computer Fundamentals	5
	1.1 Introduction to Number System and Codes	
	1.2 Number Systems: Binary, Octal, Decimal, Hexadecimal,	
	1.3 Codes: Grey, BCD, Excess-3, ASCII, Boolean Algebra.	
	1.4 Logic Gates: AND, OR, NOT, NAND, NOR, EX-OR	
	1.5 Overview of computer organization and architecture.	
	1.6 Basic Organization of Computer and Block Level functional Units, Von-Neumann Model.	
2	Data Representation and Arithmetic algorithms	8
	2.1 Binary Arithmetic: Addition, Subtraction, Multiplication, Division using Sign Magnitude, 1's and 2's compliment, BCD and Hex Arithmetic Operation.	
	2.2 Booths Multiplication Algorithm, Restoring and Non-restoring Division Algorithm.	
	2.3 IEEE-754 Floating point Representation.	
3	Processor Organization and Architecture	6
	3.1 Introduction: Half adder, Full adder, MUX, DMUX, Encoder, Decoder(IC level).	
	3.2 Introduction to Flip Flop: SR, JK, D, T (Truth table).	
	3.3 Register Organization, Instruction Formats, Addressing modes, Instruction Cycle, Interpretation and sequencing.	
4	Control Unit Design	6
	4.1 Hardwired Control Unit: State Table Method, Delay Element Methods.	
	4.2 Microprogrammed Control Unit: Micro Instruction-Format, Sequencing and execution, Micro operations, Examples of microprograms.	
5	Memory Organization	6
	5.1 Introduction and characteristics of memory, Types of RAM and ROM, Memory Hierarchy, 2-level Memory Characteristic,	
	5.2 Cache Memory: Concept, locality of reference, Design problems based on	

		mapping techniques, Cache coherence and write policies. Interleaved and Associative Memory.	
6		Principles of Advanced Processor and Buses	8
	6.1	Basic Pipelined Data path and control, data dependencies, data hazards, branch hazards, delayed branch, and branch prediction, Performance measures-CPI, Speedup, Efficiency, throughput, Amdhal's law.	
	6.2	Flynn's Classification, Introduction to multicore architecture.	
	6.3	Introduction to buses: ISA, PCI, USB. Bus Contention and Arbitration.	

Textbooks:

1	R. P. Jain, "Modern Digital Electronic", McGraw-Hill Publication, 4 th Edition.
2	William Stalling, "Computer Organization and Architecture: Designing and Performance", Pearson Publication 10 TH Edition.
3	John P Hayes, "Computer Architecture and Organization", McGraw-Hill Publication, 3 RD Edition.
4	Dr. M. Usha and T. S. Shrikanth, "Computer system Architecture and Organization", Wiley publication.

References:

1	Andrew S. Tanenbaum, "Structured Computer Organization", Pearson Publication.
2	B. Govindarajalu, "Computer Architecture and Organization", McGraw-Hill Publication.
3	Malvino, "Digital computer Electronics", McGraw-Hill Publication, 3 rd Edition.
4	Smruti Ranjan Sarangi, "Computer Organization and Architecture", McGraw-Hill Publication.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links

1	https://www.classcentral.com/course/swayam-computer-organization-and-architecture-a-pedagogical-aspect-9824
2	https://nptel.ac.in/courses/106/103/106103068/
3	https://www.coursera.org/learn/comparch
4	https://www.edx.org/learn/computer-architecture

Course Code	Course Name	Credits
CSC305	Computer Graphics	3

Prerequisite: Knowledge of C Programming and Basic Mathematics.

Course Objectives

1	To equip students with the fundamental knowledge and basic technical competence in the field of Computer Graphics.
2	To emphasize on implementation aspect of Computer Graphics Algorithms.
3	To prepare the student for advance areas and professional avenues in the field of Computer Graphics

Course Outcomes: At the end of the course, the students should be able to

1	Describe the basic concepts of Computer Graphics.
2	Demonstrate various algorithms for basic graphics primitives.
3	Apply 2-D geometric transformations on graphical objects.
4	Use various Clipping algorithms on graphical objects
5	Explore 3-D geometric transformations, curve representation techniques and projections methods.
6	Explain visible surface detection techniques and Animation.

Module		Detailed Content	Hours
1		Introduction and Overview of Graphics System:	02
	1.1	Definition and Representative uses of computer graphics, Overview of coordinate system, Definition of scan conversion, rasterization and rendering.	
	1.2	Raster scan & random scan displays, Architecture of raster graphics system with display processor, Architecture of random scan systems.	
2		Output Primitives:	10
	2.1	Scan conversions of point, line, circle and ellipse: DDA algorithm and Bresenham algorithm for line drawing, midpoint algorithm for circle, midpoint algorithm for ellipse drawing (Mathematical derivation for above algorithms is expected)	
	2.2	Aliasing, Antialiasing techniques like Pre and post filtering, super sampling, and pixel phasing).	
	2.3	Filled Area Primitive: Scan line Polygon Fill algorithm, inside outside tests, Boundary Fill and Flood fill algorithm.	
3		Two Dimensional Geometric Transformations	6
	3.1	Basic transformations: Translation, Scaling, Rotation	
	3.2	Matrix representation and Homogeneous Coordinates	
	3.3	Composite transformation	
	3.4	Other transformations: Reflection and Shear	
4		Two-Dimensional Viewing and Clipping	7
	4.1	Viewing transformation pipeline and Window to Viewport coordinate transformation	
	4.2	Clipping operations: Point clipping, Line clipping algorithms: Cohen-Sutherland, Liang: Barsky, Polygon Clipping Algorithms: Sutherland-Hodgeman, Weiler-Atherton.	
5		Three Dimensional Geometric Transformations, Curves and Fractal Generation	8
	5.1	3D Transformations: Translation, Rotation, Scaling and Reflection	

	5.2	Composite transformations: Rotation about an arbitrary axis	
	5.3	Projections – Parallel, Perspective. (Matrix Representation)	
	5.4	Bezier Curve, B-Spline Curve, Fractal-Geometry: Fractal Dimension, Koch Curve.	
6		Visible Surface Detection and Animation	6
	6.1	Visible Surface Detection: Classification of Visible Surface Detection algorithm, Back Surface detection method, Depth Buffer method, Area Subdivision method	
	6.2	Animation: Introduction to Animation, Traditional Animation Techniques, Principles of Animation, Key framing: Character and Facial Animation, Deformation, Motion capture	

Textbooks:

1	Hearn & Baker, “Computer Graphics C version”, 2nd Edition, Pearson Publication
2	James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, “Computer Graphics Principles and Practice in C”, 2 nd Edition, Pearson Publication
3	Samit Bhattacharya, “Computer Graphics”, Oxford Publication

References:

1	D. Rogers, “Procedural Elements for Computer Graphics”, Tata McGraw-Hill Publications.
2	Zhigang Xiang, Roy Plastock, “Computer Graphics”, Schaum’s Outlines McGraw-Hill Education
3	Rajesh K. Maurya, “Computer Graphics”, Wiley India Publication.
4	F. S. Hill, “Computer Graphics using OpenGL”, Third edition, Pearson Publications.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules

Useful Links

1	https://www.classcentral.com/course/interactivegraphics-2067
2	https://swayam.gov.in/nd2_ntr20_ed15/preview
3	https://nptel.ac.in/courses/106/106/106106090/
4	https://www.edx.org/course/computer-graphics-2

Lab Code	Lab Name	Credit
CSL301	Data Structures Lab	1

Prerequisite: C Programming Language.

Lab Objectives:

1	To implement basic data structures such as arrays, linked lists, stacks and queues
2	Solve problem involving graphs, and trees
3	To develop application using data structure algorithms
4	Compute the complexity of various algorithms.

Lab Outcomes:

1	Students will be able to implement linear data structures & be able to handle operations like insertion, deletion, searching and traversing on them.
2	Students will be able to implement nonlinear data structures & be able to handle operations like insertion, deletion, searching and traversing on them
3	Students will be able to choose appropriate data structure and apply it in various problems
4	Students will be able to select appropriate searching techniques for given problems.

Suggested Experiments: Students are required to complete at least 10 experiments.

Star (*) marked experiments are compulsory.

Sr. No.	Name of the Experiment
1*	Implement Stack ADT using array.
2*	Convert an Infix expression to Postfix expression using stack ADT.
3*	Evaluate Postfix Expression using Stack ADT.
4	Applications of Stack ADT.
5*	Implement Linear Queue ADT using array.
6*	Implement Circular Queue ADT using array.
7	Implement Priority Queue ADT using array.
8*	Implement Singly Linked List ADT.
9*	Implement Circular Linked List ADT.
10	Implement Doubly Linked List ADT.
11*	Implement Stack / Linear Queue ADT using Linked List.
12*	Implement Binary Search Tree ADT using Linked List.
13*	Implement Graph Traversal techniques: a) Depth First Search b) Breadth First Search
14	Applications of Binary Search Technique.

Useful Links:

1	www.leetcode.com
2	www.hackerrank.com
3	www.cs.usfca.edu/~galles/visualization/Algorithms.html
4	www.codechef.com

Term Work:

1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Oral & Practical exam

	Based on the entire syllabus of CSL301 and CSC303

Lab Code	Lab Name	Credit
CSL302	Digital Logic & Computer Organization and Architecture Lab	1

Prerequisite: C Programming Language.

Lab Objectives:

1	To implement operations of the arithmetic unit using algorithms.
2	Design and simulate different digital circuits.
3	To design memory subsystem including cache memory.
4	To demonstrate CPU and ALU design.

Lab Outcomes:

1	To understand the basics of digital components
2	Design the basic building blocks of a computer: ALU, registers, CPU and memory
3	To recognize the importance of digital systems in computer architecture
4	To implement various algorithms for arithmetic operations.

List of Experiments:

Sr. No.	Name of the Experiment
1	To verify the truth table of various logic gates using ICs.
2	To realize the gates using universal gates
3	Code conversion.
4	To realize half adder and full adder.
5	To implement logic operation using MUX IC.
6	To implement logic operation decoder IC.
7	Study of flip flop IC.
8	To implement ripple carry adder.
9	To implement carry look ahead adder.
10	To implement Booth's algorithm.
11	To implement restoring division algorithm.
12	To implement non restoring division algorithm.
13	To implement ALU design.
14	To implement CPU design.
15	To implement memory design.
16	To implement cache memory design.

Note:

1	Any Four experiments from Exp. No. 1 to Exp. No. 7 using hardware.
2	Any Six experiments from Exp. No. 8 to Exp. No. 16 using Virtual Lab, expect Exp. No 10,11 and 12.
3	Exp. No. 10 to Exp. No. 12 using Programming language.

Digital Material:

1	Manual to use Virtual Lab simulator for Computer Organization and Architecture developed by the Department of CSE, IIT Kharagpur.
2	Link http://cse10-iitkgp.virtual-labs.ac.in/

Term Work:

1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of "Digital Logic & Computer Organization and Architecture"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.

4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)

Course Code	Lab Name	Credits
CSL303	Computer Graphics Lab	1

Prerequisite: C Programming Language.

Lab Objectives:

1	Understand the need of developing graphics application
2	Learn algorithmic development of graphics primitives like line, circle, polygon etc.
3	Learn the representation and transformation of graphical images and pictures

Lab Outcomes: At the end of the course, the students should be able to

1	Implement various output and filled area primitive algorithms
2	Apply transformation, projection and clipping algorithms on graphical objects.
3	Perform curve and fractal generation methods.
4	Develop a Graphical application/Animation based on learned concept

Content:

Scan conversions: lines, circles, ellipses. Filling algorithms, clipping algorithms. 2D and 3D transformation Curves Visible surface determination. Simple animations Application of these through exercises in C/C++

List of Suggested Experiments:

Sr. No.	Name of the Experiment
1	Implement DDA Line Drawing algorithm (dotted/dashed/thick)
2	Implement Bresenham's Line algorithm(dotted/dashed/thick)
3	Implement midpoint Circle algorithm.
4	Implement midpoint Ellipse algorithm.
5	Implement Area Filling Algorithm: Boundary Fill, Flood Fill.
6	Implement Scan line Polygon Filling algorithm.
7	Implement Curve: Bezier for n control points, B Spline (Uniform)(at least one)
8	Implement Fractal generation method (anyone)
9	Character Generation: Bit Map method and Stroke Method
10	Implement 2D Transformations: Translation, Scaling, Rotation, Reflection, Shear.
11	Implement Line Clipping Algorithm: Cohen Sutherland / Liang Barsky.
12	Implement polygon clipping algorithm (at least one)
13	Program to perform 3D transformation.
14	Perform projection of a 3D object on Projection Plane: Parallel and Perspective.
15	Perform Animation (such as Rising Sun, Moving Vehicle, Smileys, Screen saver etc.)

Term Work:

1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments
3	Mini Project to perform using C /C++/Java/OpenGL/Blender/ any other tool (2/3 students per group). Possible Ideas: Animation using multiple objects, Game development, Graphics editor: Like Paint brush, Text editor etc.
4	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5	Total 25 Marks (Experiments: 10-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks, Mini Project: 5-marks)

Oral & Practical exam

Based on the above contents and entire syllabus of CSC305

Lab Code	Lab Name	Credits
CSL304	Skill based Lab Course: Object Oriented Programming with Java	2

Prerequisite: Structured Programming Approach

Lab Objectives:

1	To learn the basic concepts of object-oriented programming
2	To study JAVA programming language
3	To study various concepts of JAVA programming like multithreading, exception Handling, packages, etc.
4	To explain components of GUI based programming.

Lab Outcomes: At the end of the course, the students should be able to

1	To apply fundamental programming constructs.
2	To illustrate the concept of packages, classes and objects.
3	To elaborate the concept of strings, arrays and vectors.
4	To implement the concept of inheritance and interfaces.
5	To implement the concept of exception handling and multithreading.
6	To develop GUI based application.

Module		Detailed Content	Hours
1		Introduction to Object Oriented Programming	2
	1.1	OOP concepts: Objects, class, Encapsulation, Abstraction, Inheritance, Polymorphism, message passing.	
	1.2	Java Virtual Machine	
	1.3	Basic programming constructs: variables, data types, operators, unsigned right shift operator, expressions, branching and looping.	
2		Class, Object, Packages and Input/output	6
	2.1	Class, object, data members, member functions Constructors, types, static members and functions Method overloading Packages in java, types, user defined packages Input and output functions in Java, Buffered reader class, scanner class	
3		Array, String and Vector	3
	3.1	Array, Strings, String Buffer, Vectors	
4		Inheritance	4
	4.1	Types of inheritance, Method overriding, super, abstract class and abstract method, final, Multiple inheritance using interface, extends keyword	
5		Exception handling and Multithreading	5
	5.1	Exception handling using try, catch, finally, throw and throws, Multiple try and catch blocks, user defined exception Thread lifecycle, thread class methods, creating threads using extends and implements keyword.	
6		GUI programming in JAVA	6
	6.1	Applet and applet life cycle, creating applets, graphics class functions, parameter passing to applet, Font and color class. Event handling using event class AWT: working with windows, using AWT controls for GUI design Swing class in JAVA	

	Introduction to JDBC, JDBC-ODBC connectivity, JDBC architecture.	

Textbooks:	
1	Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.
2	E. Balagurusamy, 'Programming with Java', McGraw Hill Education.
References:	
1	Ivor Horton, "Beginning JAVA", Wiley India.
2	Dietal and Dietal, "Java: How to Program", 8 th Edition, PHI .
3	"JAVA Programming", Black Book, Dreamtech Press.
4	"Learn to Master Java programming", Staredu solutions
Digital material:	
1	www.nptelvideos.in
2	www.w3schools.com
3	www.tutorialspoint.com
4	https://starcertification.org/Certifications/Certificate/securejava

Suggested List of Programming Assignments/laboratory Work:	
Sr. No.	Name of the Experiment
1	Programs on Basic programming constructs like branching and looping
2	Program on accepting input through keyboard.
3	Programs on class and objects
4	Program on method and constructor overloading.
5	Program on Packages
6	Program on 2D array, strings functions
7	Program on String Buffer and Vectors
8	Program on types of inheritance
9	Program on Multiple Inheritance
10	Program on abstract class and abstract methods.
11	Program using super and final keyword
12	Program on Exception handling
13	Program on user defined exception
14	Program on Multithreading
15	Program on Graphics class
16	Program on applet class
17	Program to create GUI application
18	Mini Project based on the content of the syllabus (Group of 2-3 students)

Term Work:	
1	Term work should consist of 15 experiments.
2	Journal must include at least 2 assignments
3	Mini Project based on the content of the syllabus (Group of 2-3 students)
4	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5	Total 50-Marks (Experiments: 15-marks, Attendance: 05-marks, Assignments: 05-marks, Mini Project: 20-marks, MCQ as a part of lab assignments: 5-marks)

Oral & Practical exam	
Based on the entire syllabus of CSL 304: Skill based Lab Course: Object Oriented Programming with Java	

Course code	Course Name	Credits
CSM301	Mini Project A	02

Objectives	
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.
Outcome: Learner will be able to...	
1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inferences from available results through theoretical/ experimental/simulations.
5	Analyze the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices
7	Excel in written and oral communication.
8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9	Demonstrate project management principles during project work.
Guidelines for Mini Project	
1	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
3	Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
4	A logbook to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
5	Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
6	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
7	Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
9	With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Term Work		
The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.		
In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.		
Distribution of Term work marks for both semesters shall be as below:		Marks
1	Marks awarded by guide/supervisor based on logbook	10
2	Marks awarded by review committee	10
3	Quality of Project report	05
Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines		
One-year project:		
1	In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group. - First shall be for finalization of problem - Second shall be on finalization of proposed solution of problem.	
2	In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. - First review is based on readiness of building working prototype to be conducted. - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.	
Half-year project:		
1	In this case in one semester students' group shall complete project in all aspects including, - Identification of need/problem - Proposed final solution - Procurement of components/systems - Building prototype and testing	
2	Two reviews will be conducted for continuous assessment, - First shall be for finalization of problem and proposed solution - Second shall be for implementation and testing of solution.	
Assessment criteria of Mini Project.		
Mini Project shall be assessed based on following criteria;		
1	Quality of survey/ need identification	
2	Clarity of Problem definition based on need.	
3	Innovativeness in solutions	
4	Feasibility of proposed problem solutions and selection of best solution	
5	Cost effectiveness	
6	Societal impact	
7	Innovativeness	
8	Cost effectiveness and Societal impact	
9	Full functioning of working model as per stated requirements	

10	Effective use of skill sets
11	Effective use of standard engineering norms
12	Contribution of an individual's as member or leader
13	Clarity in written and oral communication
	In one year, project , first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
	In case of half year project all criteria's in generic may be considered for evaluation of performance of students in mini project.
Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
3	Students shall be motivated to publish a paper based on the work in Conferences/students competitions.
Mini Project shall be assessed based on following points;	
1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individual's as member or leader
8	Clarity in written and oral communication

Course Code	Course Name	Credits
CSC401	Engineering Mathematics-IV	4

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III, Binomial Distribution.

Course Objectives: The course aims to learn:

- 1 Matrix algebra to understand engineering problems.
- 2 Line and Contour integrals and expansion of a complex valued function in a power series.
- 3 Z-Transforms and Inverse Z-Transforms with its properties.
- 4 The concepts of probability distributions and sampling theory for small samples.
- 5 Linear and Non-linear programming problems of optimization.

Course Outcomes: On successful completion, of course, learner/student will be able to:

- 1 Apply the concepts of eigenvalues and eigenvectors in engineering problems.
- 2 Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
- 3 Apply the concept of Z- transformation and inverse in engineering problems.
- 4 Use the concept of probability distribution and sampling theory to engineering problems.
- 5 Apply the concept of Linear Programming Problems to optimization.
- 6 Solve Non-Linear Programming Problems for optimization of engineering problems.

Module	Detailed Contents	Hours
1	Linear Algebra (Theory of Matrices)	7
	1.1 Characteristic Equation, Eigenvalues and Eigenvectors, and properties (without proof)	
	1.2 Cayley-Hamilton Theorem (without proof), verification and reduction of higher degree polynomials	
	1.3 Similarity of matrices, diagonalizable and non-diagonalizable matrices	
	1.4 Self-learning Topics: Derogatory and non-derogatory matrices, Functions of Square Matrix, Linear Transformations, Quadratic forms.	
2	Complex Integration	7
	2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof).	
	2.2 Taylor's and Laurent's series (without proof).	
	2.3 Definition of Singularity, Zeroes, poles of $f(z)$, Residues, Cauchy's Residue Theorem (without proof)	
	2.4 Self-learning Topics: Application of Residue Theorem to evaluate real integrations.	
3	Z Transform	5
	3.1 Definition and Region of Convergence, Transform of Standard Functions: $\{k^n a^k\}, \{a^{ k }\}, \{k^n C_n a^k\}, \{c^k \sin(\alpha k + \beta)\}, \{c^k \sinh \alpha k\}, \{c^k \cosh \alpha k\}.$	
	3.2 Properties of Z Transform: Change of Scale, Shifting Property, Multiplication, and Division by k, Convolution theorem.	
	3.3 Inverse Z transform: Partial Fraction Method, Convolution Method.	
	3.4 Self-learning Topics: Initial value theorem, Final value theorem, Inverse of Z Transform by Binomial Expansion	
4	Probability Distribution and Sampling Theory	7
	4.1 Probability Distribution: Poisson and Normal distribution	

	4.2	Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom.	
	4.3	Students' t-distribution (Small sample). Test the significance of mean and Difference between the means of two samples. Chi-Square Test: Test of goodness of fit and independence of attributes, Contingency table.	
	4.4	Self-learning Topics: Test significance for Large samples, Estimate parameters of a population, Yate's Correction.	
5	Linear Programming Problems		6
	5.1	Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, slack variables, surplus variables, Simplex method.	
	5.2	Artificial variables, Big-M method (Method of penalty)	
	5.3	Duality, Dual of LPP and Dual Simplex Method	
	5.4	Self-learning Topics: Sensitivity Analysis, Two-Phase Simplex Method, Revised Simplex Method.	
6	Nonlinear Programming Problems		7
	6.1	NLPP with one equality constraint (two or three variables) using the method of Lagrange's multipliers	
	6.2	NLPP with two equality constraints	
	6.3	NLPP with inequality constraint: Kuhn-Tucker conditions	
	6.4	Self-learning Topics: Problems with two inequality constraints, Unconstrained optimization: One-dimensional search method (Golden Search method, Newton's method). Gradient Search method	

References:

1	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons.
2	R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Narosa.
3	Brown and Churchill, "Complex Variables and Applications", McGraw-Hill Education.
4	T. Veerarajan, "Probability, Statistics and Random Processes", McGraw-Hill Education.
5	Hamdy A Taha, "Operations Research: An Introduction", Pearson.
6	S.S. Rao, "Engineering Optimization: Theory and Practice", Wiley-Blackwell.
7	Hira and Gupta, "Operations Research", S. Chand Publication.

Term Work:

General Instructions:

1	Batch wise tutorial shave to be conducted. The number of students per batch will be as per University pattern for practical.
2	Students must be encouraged to write at least 6 class tutorials on the entire syllabus.
3	A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This will be considered as a mini project in Engineering Mathematics. This project will be graded out of 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows:

1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment Test:

The assessment consists of two class tests of 20 marks each. The 1st class test (Internal Assessment I) has to be conducted when approximately 40% of the syllabus is completed. The 2nd class test has to be conducted (Internal Assessment II) when an additional 35% syllabus is

completed. The duration of each test will be for one hour.

End Semester Theory Examination:

1	The question paper will comprise a total of 6 questions, each carrying 20 marks.
2	Out of the 6 questions, 4 questions have to be attempted.
3	Question 1, based on the entire syllabus, will have 4 sub-questions of 5 marks each and is compulsory.
4	Question 2 to Question 6 will have 3 sub-questions, each of 6, 6, and 8 marks, respectively.
5	Each sub-question in (4) will be from different modules of the syllabus.
6	Weightage of each module will be proportional to the number of lecture hours, as mentioned in the syllabus.

Course Code	Course Name	Credit
CSC402	Analysis of Algorithms	3

Prerequisite: Data structure concepts, Discrete structures

Course Objectives:

1	To provide mathematical approaches for Analysis of Algorithms
2	To understand and solve problems using various algorithmic approaches
3	To analyze algorithms using various methods

Course Outcomes: At the end of the course learner will be able to

1	Analyze the running time and space complexity of algorithms.
2	Describe, apply and analyze the complexity of divide and conquer strategy.
3	Describe, apply and analyze the complexity of greedy strategy.
4	Describe, apply and analyze the complexity of dynamic programming strategy.
5	Explain and apply backtracking, branch and bound.
6	Explain and apply string matching techniques.

Module		Detailed Contents	Hours
1		Introduction	8
	1.1	Performance analysis, space, and time complexity Growth of function, Big-Oh, Omega Theta notation Mathematical background for algorithm analysis. Complexity class: Definition of P, NP, NP-Hard, NP-Complete Analysis of selection sort, insertion sort.	
	1.2	Recurrences: The substitution method, Recursion tree method, Master method	
2		Divide and Conquer Approach	6
	2.1	General method, Merge sort, Quick sort, Finding minimum and maximum algorithms and their Analysis, Analysis of Binary search.	
3		Greedy Method Approach	6
	3.1	General Method, Single source shortest path: Dijkstra Algorithm Fractional Knapsack problem, Job sequencing with deadlines, Minimum cost spanning trees: Kruskal and Prim's algorithms	
4		Dynamic Programming Approach	9
	4.1	General Method, Multistage graphs, Single source shortest path: Bellman Ford Algorithm All pair shortest path: Floyd Warshall Algorithm, Assembly-line scheduling Problem 0/1 knapsack Problem, Travelling Salesperson problem, Longest common subsequence	
5		Backtracking and Branch and bound	6
	5.1	General Method, Backtracking: N-queen problem, Sum of subsets, Graph coloring	
	5.2	Branch and Bound: Travelling Salesperson Problem, 15 Puzzle problem	
6		String Matching Algorithms	4
	6.1	The Naïve string-matching algorithm, The Rabin Karp algorithm, The Knuth-Morris-Pratt algorithm	

Textbooks:

1	T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", 2 nd Edition, PHI Publication 2005.
2	Ellis Horowitz, Sartaj Sahni, S. Rajsekaran. "Fundamentals of computer algorithms" University Press.

References:

1	Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, “Algorithms”, Tata McGraw-Hill Edition.
2	S. K. Basu, “Design Methods and Analysis of Algorithm”, PHI

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links

1	https://nptel.ac.in/courses/106/106/106106131/
2	https://swayam.gov.in/nd1_noc19_cs47/preview
3	https://www.coursera.org/specializations/algorithms
4	https://www.mooc-list.com/tags/algorithms

Course Code:	Course Title	Credit
CSC403	Database Management System	3

Prerequisite: Data Structures	
Course Objectives:	
1	Develop entity relationship data model and its mapping to relational model
2	Learn relational algebra and Formulate SQL queries
3	Apply normalization techniques to normalize the database
4	Understand concept of transaction, concurrency control and recovery techniques.
Course Outcomes:	
1	Recognize the need of database management system
2	Design ER and EER diagram for real life applications
3	Construct relational model and write relational algebra queries.
4	Formulate SQL queries
5	Apply the concept of normalization to relational database design.
6	Describe the concept of transaction, concurrency and recovery.

Module		Content	Hrs
1		Introduction Database Concepts	3
	1.1	Introduction, Characteristics of databases, File system v/s Database system, Data abstraction and data Independence, DBMS system architecture, Database Administrator	
2		Entity–Relationship Data Model	6
	2.1	The Entity-Relationship (ER) Model: Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Keys, Relationship constraints: Cardinality and Participation, Extended Entity-Relationship (EER) Model: Generalization, Specialization and Aggregation	
3		Relational Model and relational Algebra	8
	3.1	Introduction to the Relational Model, relational schema and concept of keys. Mapping the ER and EER Model to the Relational Model, Relational Algebra-operators, Relational Algebra Queries.	
4		Structured Query Language (SQL)	6
	4.1	Overview of SQL, Data Definition Commands, Integrity constraints: key constraints, Domain Constraints, Referential integrity , check constraints, Data Manipulation commands, Data Control commands, Set and string operations, aggregate function-group by, having, Views in SQL, joins, Nested and complex queries, Triggers	
5		Relational-Database Design	6
	5.1	Pitfalls in Relational-Database designs, Concept of normalization, Function Dependencies, First Normal Form, 2NF, 3NF, BCNF.	
6		Transactions Management and Concurrency and Recovery	10
	6.1	Transaction concept, Transaction states, ACID properties, Transaction Control Commands, Concurrent Executions, Serializability-Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols, Recovery System: Log based recovery, Deadlock handling	

Textbooks:

1	Korth, Silberchatz, Sudarshan, Database System Concepts, 6 th Edition, McGraw Hill
2	Elmasri and Navathe, Fundamentals of Database Systems, 5 th Edition, Pearson Education
3	Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH

References:

1	Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management, Thomson Learning, 5 th Edition.
2	Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3	G. K. Gupta, Database Management Systems, McGraw Hill, 2012

Assessment:**Internal Assessment:**

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links

1	https://nptel.ac.in/courses/106/105/106105175/
2	https://swayam.gov.in/nd1_noc19_cs46/preview
3	https://www.classcentral.com/course/swayam-database-management-system-9914
4	https://www.mooc-list.com/tags/dbms

Course Code	Course Name	Credit
CSC404	Operating System	03

Prerequisites: Data structures and Computer architecture

Course Objectives:

1	1. To introduce basic concepts and functions of operating systems.
2	2. To understand the concept of process, thread and resource management.
3	3. To understand the concepts of process synchronization and deadlock.
4	4. To understand various Memory, I/O and File management techniques.

Course Outcome:

1	Understand the objectives, functions and structure of OS
2	Analyze the concept of process management and evaluate performance of process scheduling algorithms.
3	Understand and apply the concepts of synchronization and deadlocks
4	Evaluate performance of Memory allocation and replacement policies
5	Understand the concepts of file management.
	Apply concepts of I/O management and analyze techniques of disk scheduling.

Module	Detailed Content	Hours
1	Operating system Overview	4
	1.1 Introduction, Objectives, Functions and Evolution of Operating System	
	1.2 Operating system structures: Layered, Monolithic and Microkernel	
	1.3 Linux Kernel, Shell and System Calls	
2	Process and Process Scheduling	9
	2.1 Concept of a Process, Process States, Process Description, Process Control Block.	
	2.2 Uniprocessor Scheduling-Types: Preemptive and Non-preemptive scheduling algorithms (FCFS, SJF, SRTN, Priority, RR)	
	2.3 Threads: Definition and Types, Concept of Multithreading	
3	Process Synchronization and Deadlocks	9
	3.1 Concurrency: Principles of Concurrency, Inter-Process Communication, Process Synchronization.	
	3.2 Mutual Exclusion: Requirements, Hardware Support (TSL), Operating System Support (Semaphores), Producer and Consumer problem.	
	3.3 Principles of Deadlock: Conditions and Resource, Allocation Graphs, Deadlock Prevention, Deadlock Avoidance: Banker's Algorithm, Deadlock Detection and Recovery, Dining Philosophers Problem.	
4	Memory Management	9
	4.1 Memory Management Requirements, Memory Partitioning: Fixed, Partitioning, Dynamic Partitioning, Memory Allocation Strategies: Best-Fit, First Fit, Worst Fit, Paging and Segmentation, TLB	
	4.2 Virtual Memory: Demand Paging, Page Replacement Strategies: FIFO, Optimal, LRU, Thrashing	
5	File Management	4

	5.1	Overview, File Organization and Access, File Directories, File Sharing	
6		I/O management	4
	6.1	I/O devices, Organization of the I/O Function, Disk Organization, I/O Management and Disk Scheduling: FCFS, SSTF, SCAN, CSCAN, LOOK, C-LOOK.	

Textbooks:

1	William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8 th Edition, 2014, ISBN-10: 0133805913 • ISBN-13: 9780133805918.
2	Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley & Sons, Inc., 9 th Edition, 2016, ISBN 978-81-265-5427-0

References:

1	Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3 rd Edition
2	Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3 rd Edition.
3	Maurice J. Bach, “Design of UNIX Operating System”, PHI
4	Sumitabha Das, “UNIX: Concepts and Applications”, McGraw Hill, 4 th Edition

Assessment:
Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules

Useful Links

1	https://swayam.gov.in/nd1_noc19_cs50/preview
2	https://nptel.ac.in/courses/117/106/117106113/
3	https://www.classcentral.com/course/swayam-introduction-to-operating-systems-6559

Course Code	Course Name	Credits
CSC405	Microprocessor	3

Prerequisites: Digital Logic and Computer Architecture

Course objectives:

- 1 To equip students with the fundamental knowledge and basic technical competence in the field of Microprocessors.
- 2 To emphasize on instruction set and logic to build assembly language programs.
- 3 To prepare students for higher processor architectures and embedded systems

Course outcomes: On successful completion of course, learner will be able to:

- 1 Describe core concepts of 8086 microprocessor.
- 2 Interpret the instructions of 8086 and write assembly and Mixed language programs.
- 3 Identify the specifications of peripheral chip.
- 4 Design 8086 based system using memory and peripheral chips.
- 5 Appraise the architecture of advanced processors
- 6 Understand hyperthreading technology

Module	Detailed Contents	Hours
1	The Intel Microprocessors 8086 Architecture	8
	1.1 8086CPU Architecture,	
	1.2 Programmer's Model	
	1.3 Functional Pin Diagram	
	1.4 Memory Segmentation	
	1.5 Banking in 8086	
	1.6 Demultiplexing of Address/Data bus	
	1.7 Functioning of 8086 in Minimum mode and Maximum mode	
	1.8 Timing diagrams for Read and Write operations in minimum and maximum mode	
	1.9 Interrupt structure and its servicing	
2	Instruction Set and Programming	6
	2.1 Addressing Modes	
	2.2 Instruction set-Data Transfer Instructions, String Instructions, Logical Instructions, Arithmetic Instructions, Transfer of Control Instructions, Processor Control Instructions	
	2.3 Assembler Directives and Assembly Language Programming, Macros, Procedures	
3	Memory and Peripherals interfacing	8
	3.1 Memory Interfacing - RAM and ROM Decoding Techniques – Partial and Absolute	
	3.2 8255-PPI-Block diagram, CWR, operating modes, interfacing with 8086.	
	3.3 8257-DMAC-Block diagram, DMA operations and transfer modes.	
	3.4 Programmable Interrupt Controller 8259-Block Diagram, Interfacing the 8259 in single and cascaded mode.	
4	Intel 80386DX Processor	7
	4.1 Architecture of 80386 microprocessor	
	4.2 80386 registers-General purpose Registers, EFLAGS and Control	

		registers	
	4.3	Real mode, Protected mode, virtual 8086 mode	
	4.4	80386 memory management in Protected Mode – Descriptors and selectors, descriptor tables, the memory paging mechanism	
5	Pentium Processor		6
	5.1	Pentium Architecture	
	5.2	Superscalar Operation,	
	5.3	Integer & Floating-Point Pipeline Stages,	
	5.4	Branch Prediction Logic,	
	5.5	Cache Organization and	
	5.6	MESI protocol	
6	Pentium 4		4
	6.1	Comparative study of 8086, 80386, Pentium I, Pentium II and Pentium III	
	6.2	Pentium 4: Net burst micro architecture.	
	6.3	Instruction translation look aside buffer and branch prediction	
	6.4	Hyper threading technology and its use in Pentium 4	

Textbooks:

1	John Uffenbeck, “8086/8088 family: Design Programming and Interfacing”, PHI.
2	Yu-Cheng Liu, Glenn A. Gibson, “Microcomputer System: The 8086/8088 Family, Architecture, Programming and Design”, Prentice Hall
3	Walter A. Triebel, “The 80386DX Microprocessor: hardware, Software and Interfacing”, Prentice Hall
4	Tom Shanley and Don Anderson, “Pentium Processor System Architecture”, Addison-Wesley.
5	K. M. Bhurchandani and A. K. Ray, “Advanced Microprocessors and Peripherals”, McGraw Hill

References:

1	Barry B. Brey, “Intel Microprocessors”, 8 th Edition, Pearson Education India
2	Douglas Hall, “Microprocessor and Interfacing”, Tata McGraw Hill.
3	Intel Manual
4	Peter Abel, “IBM PC Assembly language and Programming”, 5 th Edition, PHI
5	James Antonakons, “The Pentium Microprocessor”, Pearson Education

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of 6 questions, each carrying 20 marks.
2	The students need to solve total 4 questions.
3	Question No.1 will be compulsory and based on entire syllabus.
4	Remaining question (Q.2 to Q.6) will be selected from all the modules.

Useful Links

1	https://swayam.gov.in/nd1_noc20_ee11/preview
2	https://nptel.ac.in/courses/108/105/108105102/
3	https://www.classcentral.com/course/swayam-microprocessors-and-microcontrollers-9894
4	https://www.mooc-list.com/tags/microprocessors

Course Name	Lab Name	Credit
CSL401	Analysis of Algorithms Lab	1

Prerequisite: Basic knowledge of programming and data structure

Lab Objectives:

1	To introduce the methods of designing and analyzing algorithms
2	Design and implement efficient algorithms for a specified application
3	Strengthen the ability to identify and apply the suitable algorithm for the given real-world problem.
4	Analyze worst-case running time of algorithms and understand fundamental algorithmic problems.

Lab Outcomes: At the end of the course, the students will be able to

1	Implement the algorithms using different approaches.
2	Analyze the complexities of various algorithms.
3	Compare the complexity of the algorithms for specific problem.

Description

Implementation can be in any language.

Suggested Practical List:

Sr No		Suggested Experiment List
1		Introduction
	1.1	Selection sort, Insertion sort
2		Divide and Conquer Approach
	2.1	Finding Minimum and Maximum, Merge sort, Quick sort, Binary search
3		Greedy Method Approach
	3.1	Single source shortest path- Dijkstra Fractional Knapsack problem Job sequencing with deadlines Minimum cost spanning trees-Kruskal and Prim's algorithm
4		Dynamic Programming Approach
	4.1	Single source shortest path- Bellman Ford All pair shortest path- Floyd Warshall 0/1 knapsack Travelling salesperson problem Longest common subsequence
5		Backtracking and Branch and bound
	5.1	N-queen problem Sum of subsets Graph coloring
6		String Matching Algorithms
	6.1	The Naïve string-matching Algorithms The Rabin Karp algorithm The Knuth-Morris-Pratt algorithm

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Analysis of Algorithms”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC402: Analysis of Algorithms

Lab Code	Lab Name	Credit
CSL402	Database Management system Lab	1

Prerequisite: Discrete Structures

Lab Objectives:

1	To explore design and develop of relational model
2	To present SQL and procedural interfaces to SQL comprehensively
3	To introduce the concepts of transactions and transaction processing

Lab Outcomes: At the end of the course, the students will be able to

1	Design ER /EER diagram and convert to relational model for the realworld application.
2	Apply DDL, DML, DCL and TCL commands
3	Write simple and complex queries
4	UsePL / SQL Constructs.
5	Demonstrate the concept of concurrent transactions execution and frontend-backend connectivity

Suggested List of Experiments

Sr. No.	Title of Experiment
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System
4	Apply DML Commands for the specified system
5	Perform Simple queries, string manipulation operations and aggregate functions.
6	Implement various Join operations.
7	Perform Nested and Complex queries
8	Perform DCL and TCL commands
9	Implement procedure and functions
10	Implementation of Views and Triggers.
11	Demonstrate Database connectivity
12	Implementation and demonstration of Transaction and Concurrency control techniques using locks.

Term Work:

1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Database Management System”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)

Oral & Practical exam

Course Code	Course Name	Credit
CSL403	Operating System Lab	01
	Based on the entire syllabus of CSC403: Database Management System	

Prerequisite: Knowledge on Operating system principles

Lab Objectives:

1	To gain practical experience with designing and implementing concepts of operating systems such as system calls, CPU scheduling, process management, memory management, file systems and deadlock handling using C language in Linux environment.
2	To familiarize students with the architecture of Linux OS.
3	To provide necessary skills for developing and debugging programs in Linux environment.
4	To learn programmatically to implement simple operation system mechanisms

Lab Outcomes: At the end of the course, the students will be able to

1	Demonstrate basic Operating system Commands, Shell scripts, System Calls and API wrt Linux
2	Implement various process scheduling algorithms and evaluate their performance.
3	Implement and analyze concepts of synchronization and deadlocks.
4	Implement various Memory Management techniques and evaluate their performance.
5	Implement and analyze concepts of virtual memory.
6	Demonstrate and analyze concepts of file management and I/O management techniques.

Suggested List of Experiments

Sr. No.	Content
1	Explore Linux Commands
1.1	Explore usage of basic Linux Commands and system calls for file, directory and process management. For eg: (mkdir, chdir, cat, ls, chown, chmod, chgrp, ps etc. system calls: open, read, write, close, getpid, setpid, getuid, getgid, getegid, geteuid. sort, grep, awk, etc.)
2	Linux shell script
2.1	Write shell scripts to do the following: a. Display OS version, release number, kernel version b. Display top 10 processes in descending order c. Display processes with highest memory usage. d. Display current logged in user and log name. Display current shell, home directory, operating system type, current path setting, current working directory.
3	Linux- API
3.1	Implement any one basic commands of linux like ls, cp, mv and others using kernel APIs.
4	Linux- Process
4.1	a. Create a child process in Linux using the fork system call. From the child process obtain the process ID of both child and parent by using getpid and getppid system call. b. Explore wait and waitpid before termination of process.
5	Process Management: Scheduling

	5.1	a. Write a program to demonstrate the concept of non-preemptive scheduling algorithms. b. Write a program to demonstrate the concept of preemptive scheduling algorithms
6		Process Management: Synchronization
	6.1	a. Write a C program to implement solution of Producer consumer problem through Semaphore
7		Process Management: Deadlock
	7.1	a. Write a program to demonstrate the concept of deadlock avoidance through Banker's Algorithm b. Write a program demonstrate the concept of Dining Philospher's Problem
8		Memory Management
	8.1	a. Write a program to demonstrate the concept of MVT and MFT memory management techniques b. Write a program to demonstrate the concept of dynamic partitioning placement algorithms i.e. Best Fit, First Fit, Worst-Fit etc.
9		Memory Management: Virtual Memory
	9.1	a. Write a program to demonstrate the concept of demand paging for simulation of Virtual Memory implementation b. Write a program in C demonstrate the concept of page replacement policies for handling page faults eg: FIFO, LRU etc.
10		File Management & I/O Management
	10.1	a. Write a C program to simulate File allocation strategies typically sequential, indexed and linked files b. Write a C program to simulate file organization of multi-level directory structure. c. Write a program in C to do disk scheduling - FCFS, SCAN, C-SCAN

Term Work:	
1	Term work should consist of 10 experiments covering all modules.
2	Journal must include at least 2 assignments on content of theory and practical of "Database Management System"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC405: Operating System.

Lab Code	Lab Name	Credits
CSL404	Microprocessor Lab	1

Prerequisite: Basic knowledge digital integrated circuits

Lab Objectives:

1	To emphasize on use of Assembly language program.
2	To prepare students for advanced subjects like embedded system and IOT.

Lab Outcomes: At the end of the course, the students will be able to

1	Use appropriate instructions to program microprocessor to perform various task
2	Develop the program in assembly/ mixed language for Intel 8086 processor
3	Demonstrate the execution and debugging of assembly/ mixed language program

Suggested List of Experiments:

Sr. No.	Title of Experiments
1	Use of programming tools (Debug/TASM/MASM/8086kit) to perform basic arithmetic operations on 8-bit/16-bit data
2	Code conversion (Hex to BCD and BCD to Hex)/ (ASCII to BCD and BCD to ASCII)
3	Assembly programming for 16-bit addition, subtraction, multiplication and division (menu based)
4	Assembly program based on string instructions (overlapping/non-overlapping block transfer/ string search/ string length)
5	Assembly program to display the contents of the flag register.
6	Any Mixed Language programs.
7	Assembly program to find the GCD/ LCM of two numbers
8	Assembly program to sort numbers in ascending/ descending order
9	Any program using INT 10H
10	Assembly program to find minimum/ maximum number from a given array.
11	Assembly Program to display a message in different color with blinking
12	Assembly program using procedure.
13	Assembly program using macro.
14	Program and interfacing using 8255.
15	Program and interfacing of ADC/ DAC/ Stepper motor.

Term Work:

1	Term work should consist of 10 experiments, out of these at least one experiment on hardware interfacing.
2	Journal must include at least 2 assignments on content of theory and practical of "Microprocessor"
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)

Oral & Practical exam

	Based on the entire syllabus of CSL501and CSC501syllabus.

Lab Code	Lab Name	Credit
CSL405	Skill Base Lab Course: Python Programming	2

Prerequisite: Knowledge of some programming language like C, Java

Lab Objectives:

1	Basics of Python programming
2	Decision Making, Data structure and Functions in Python
3	Object Oriented Programming using Python
4	Web framework for developing

Lab Outcomes: At the end of the course, the students will be able to

1	To understand basic concepts in python.
2	To explore contents of files, directories and text processing with python
3	To develop program for data structure using built in functions in python.
4	To explore django web framework for developing python-based web application.
5	To understand Multithreading concepts using python.

Module		Detailed Content	Hours
1		Python basics	5
	1.1	Data types in python, Operators in python, Input and Output, Control statement, Arrays in python, String and Character in python, Functions, List and Tuples, Dictionaries Exception, Introduction to OOP, Classes, Objects, Interfaces, Inheritance	
2		Advanced Python	4
	2.1	Files in Python, Directories, Building Modules, Packages, Text Processing, Regular expression in python.	
3		Data Structure in Python	3
	3.1	Link List, Stack, Queues, Dequeues	
4		Python Integration Primer	4
	4.1	Graphical User interface, Networking in Python, Python database connectivity, Introduction to Django	
5		Multithreading	4
	5.1	Thread and Process, Starting a thread, Threading module, Synchronizing threads, Multithreaded Priority Queue	
6		NumPy and Pandas	6
	6.1	Creating NumPy arrays, Indexing and slicing in NumPy, creating multidimensional arrays, NumPy Data types, Array Attribute, Indexing and Slicing, Creating array views copies, Manipulating array shapes I/O	
	6.2	Basics of Pandas, Using multilevel series, Series and Data Frames, Grouping, aggregating, Merge Data Frames	

Textbooks:

1	Dr. R. Nageswara Rao, "Core Python Programming", Dreamtech Press
2	Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox Publication
3	Anurag Gupta, G. P. Biswas, "Python Programming", McGraw-Hill
4	E. Balagurusamy, "Introduction to computing and problem-solving using python", McGraw Hill Education

References:

1	Learn Python the Hard Way, 3 rd Edition, Zed Shaw's Hard Way Series

2	Laura Cassell, Alan Gauld, “Python Projects”, Wrox Publication
Digital material:	
1	"The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
2	Beginning Perl, https://www.perl.org/books/beginning-perl/
3	http://spoken-tutorial.org
4	https://starcertification.org/Certifications/Certificate/python

Suggested experiments using Python:	
Sr. No.	Title of Experiments
1	Exploring basics of python like data types (strings, list, array, dictionaries, set, tuples) and control statements.
2	Creating functions, classes and objects using python. Demonstrate exception handling and inheritance.
3	Exploring Files and directories a. Python program to append data to existing file and then display the entire file b. Python program to count number of lines, words and characters in a file. c. Python program to display file available in current directory
4	Creating GUI with python containing widgets such as labels, textbox, radio, checkboxes and custom dialog boxes.
5	Menu driven program for data structure using built in function for link list, stack and queue.
6	Program to demonstrate CRUD (create, read, update and delete) operations on database (SQLite/ MySQL) using python.
7	Creation of simple socket for basic information exchange between server and client.
8	Creating web application using Django web framework to demonstrate functionality of user login and registration (also validating user detail using regular expression).
9	Programs on Threading using python.
10	Exploring basics of NumPy Methods.
11	Program to demonstrate use of NumPy: Array objects.
12	Program to demonstrate Data Series and Data Frames using Pandas.
13	Program to send email and read content of URL.

Term Work:	
1	Term work should consist of 12 experiments.
2	Journal must include at least 2 assignments
3	Mini Project based on the content of the syllabus (Group of 2-3 students)
4	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
5	Total 25 Marks (Journal: 10-marks, Attendance: 05-marks, and Mini Project: 10-marks)

Course code	Course Name	Credits
CSM401	Mini Project B	02

Objectives	
1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.
Outcome: Learner will be able to...	
1	Identify problems based on societal /research needs.
2	Apply Knowledge and skill to solve societal problems in a group.
3	Develop interpersonal skills to work as member of a group or leader.
4	Draw the proper inferences from available results through theoretical/experimental/simulations.
5	Analyze the impact of solutions in societal and environmental context for sustainable development.
6	Use standard norms of engineering practices
7	Excel in written and oral communication.
8	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
9	Demonstrate project management principles during project work.
Guidelines for Mini Project	
1	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
3	Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
4	A logbook to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
5	Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
6	Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
7	Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
9	With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Term Work		
The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.		
In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.		
Distribution of Term work marks for both semesters shall be as below:		Marks
1	Marks awarded by guide/supervisor based on logbook	10
2	Marks awarded by review committee	10
3	Quality of Project report	05
Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines		
One-year project:		
1	In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group. - First shall be for finalization of problem - Second shall be on finalization of proposed solution of problem.	
2	In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. - First review is based on readiness of building working prototype to be conducted. - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.	
Half-year project:		
1	In this case in one semester students' group shall complete project in all aspects including, - Identification of need/problem - Proposed final solution - Procurement of components/systems - Building prototype and testing	
2	Two reviews will be conducted for continuous assessment, - First shall be for finalization of problem and proposed solution - Second shall be for implementation and testing of solution.	
Assessment criteria of Mini Project.		
Mini Project shall be assessed based on following criteria;		
1	Quality of survey/ need identification	
2	Clarity of Problem definition based on need.	
3	Innovativeness in solutions	
4	Feasibility of proposed problem solutions and selection of best solution	
5	Cost effectiveness	
6	Societal impact	
7	Innovativeness	

8	Cost effectiveness and Societal impact
9	Full functioning of working model as per stated requirements
10	Effective use of skill sets
11	Effective use of standard engineering norms
12	Contribution of an individual's as member or leader
13	Clarity in written and oral communication
	In one year, project , first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
	In case of half year project all criteria's in generic may be considered for evaluation of performance of students in mini project.
Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
3	Students shall be motivated to publish a paper based on the work in Conferences/students competitions.
Mini Project shall be assessed based on following points;	
1	Quality of problem and Clarity
2	Innovativeness in solutions
3	Cost effectiveness and Societal impact
4	Full functioning of working model as per stated requirements
5	Effective use of skill sets
6	Effective use of standard engineering norms
7	Contribution of an individual's as member or leader
8	Clarity in written and oral communication

UNIVERSITY OF MUMBAI



Bachelor of Engineering

in

Electronics and Telecommunication Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year
2019–2020)

UNIVERSITY OF MUMBAI



Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	Second Year B.E. Electronics and Telecommunication Engineering
2	Eligibility for Admission	After Passing First Year Engineering as per the Ordinance 0.6242
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	Ordinance 0.6242
5	No. of Years / Semesters	8 semesters
6	Level	P.G. / U.G./~~Diploma~~ / Certificate (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / Semester (Strike out which is not applicable)
8	Status	New / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	With effect from Academic Year: 2020-2021

Date 02-07-2020

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents **from NPTEL/ Swayam Platform**

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By BoS

Technological developments in the field of electronics and telecommunication engineering have revolutionized the way people see the world today. Hence, there is a need for continuously enriching the quality of education by a regular revision in the curriculum, which will help our students achieve better employability, start-ups, and other avenues of higher studies. The current revision in the Bachelor of Engineering program (REV- 2019 'C' Scheme) aims at providing a strong foundation with required analytical concepts in the field of electronics and telecommunication engineering.

Some of the salient features of this revised curriculum are as below and they fall in line with the features in AICTE Model Curriculum.

1. The curriculum is designed in such a way that it encourages innovation and research as the total number of credits has been reduced from around 200 credits in an earlier curriculum to 171 credits in the current revision.
2. In the second and third-year curriculum, skill-based laboratories and mini-projects are introduced.
3. It will result in the students developing a problem-solving approach and will be able to meet the challenges of the future.
4. The University of Mumbai and BoS – Electronics and Telecommunication Engineering will ensure the revision of the curriculum on regular basis in the future as well and this update will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

The BoS would like to thank all the subject experts, industry representatives, alumni, and various other stakeholders for their sincere efforts and valuable time in the preparation of course contents, reviewing the contents, giving valuable suggestions, and critically analyzing the contents.

Board of Studies in Electronics and Telecommunication Engineering

Dr. Faruk Kazi: Chairman

Dr. V. N. Pawar: Member

Dr. Ravindra Duche: Member

Dr. Milind Shah: Member

Dr. R. K. Kulkarni: Member

Dr. Baban U. Rindhe: Member

Dr. Mrs. Nair: Member

Dr. Nalbarwar: Member

Dr. Sudhakar Mande: Member

Dr. S. D. Deshmukh: Member

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)
Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC301	Engineering Mathematics-III	3	--	1*	3	--	1	4
ECC302	Electronic Devices & Circuits	3	--	--	3	--	--	3
ECC303	Digital System Design	3	--	--	3	--	--	3
ECC304	Network Theory	3	--	1	3	--	1	4
ECC305	Electronic Instrumentation & Control Systems	3	--	--	3	--	--	3
ECL301	Electronic Devices & Circuits Lab	--	2	--	--	1	--	1
ECL302	Digital System Design Lab	--	2	--	--	1	--	1
ECL303	Electronic Instrumentation & Control Systems Lab	--	2	--	--	1	--	1
ECL304	Skill Lab: C++ and Java Programming	--	4	--	--	2	--	2
ECM301	Mini Project 1A	--	4 ^{\$}	--	--	2	--	2
Total		15	14	2	15	07	2	24

* Should be conducted batch wise.

\$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
ECC302	Electronic Devices & Circuits	20	20	20	80	3	--	--	100
ECC303	Digital System Design	20	20	20	80	3	--	--	100
ECC304	Network Theory	20	20	20	80	3	25	--	125
ECC305	Electronic Instrumentation & Control Systems	20	20	20	80	3	--	--	100
ECL301	Electronic Devices & Circuits Lab	--	--	--	--	--	25	25	50
ECL302	Digital System Design Lab	--	--	--	--	--	25	--	25
ECL303	Electronic Instrumentation & Control Systems Lab	--	--	--	--	--	25	--	25
ECL304	Skill Lab: C++ and Java Programming	--	--	--	--	--	25	25	50
ECM301	Mini Project 1A	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	175	75	750

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC401	Engineering Mathematics-IV	3	--	1*	3	--	1	4
ECC402	Microcontrollers	3	--	--	3	--	--	3
ECC403	Linear Integrated Circuits	3	--	--	3	--	--	3
ECC404	Signals & Systems	3	--	1	3	--	1	4
ECC405	Principles of Communication Engineering	3	--	--	3	--	--	3
ECL401	Microcontrollers Lab	--	2	--	--	1	--	1
ECL402	Linear Integrated Circuits Lab	--	2	--	--	1	--	1
ECL403	Principles of Communication Engineering Lab	--	2	--	--	1	--	1
ECL404	Skill Lab: Python Programming	--	4	--	--	2	--	2
ECM401	Mini Project 1B	--	4 ^{\$}	--	--	2	--	2
Total		15	14	2	15	7	2	24

* Should be conducted batch wise.

\$ Indicates work load of a learner (Not Faculty) for Mini Project 1B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ECC402	Microcontrollers	20	20	20	80	3	--	--	100
ECC403	Linear Integrated Circuits	20	20	20	80	3	--	--	100
ECC404	Signals & Systems	20	20	20	80	3	25	--	125
ECC405	Principles of Communication Engineering	20	20	20	80	3	--	--	100
ECL401	Microcontrollers Lab	--	--	--	--	--	25	--	25
ECL402	Linear Integrated Circuits Lab	--	--	--	--	--	25	25	50
ECL403	Principles of Communication Engineering Lab	--	--	--	--	--	25	25	50
ECL404	Skill Lab: Python Programming	--	--	--	--	--	25	25	50
ECM401	Mini Project 1B	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	175	100	775

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ECC301	Engineering Mathematics-III	03	-	01*	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Exam Duration (in Hrs.)	Term Work	Pract & Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
ECC301	Engineering Mathematics-III	20	20	20	80	03	25	-	125

* Should be conducted batch wise.

Pre-requisite:

1. FEC101-Engineering Mathematics-I
2. FEC201-Engineering Mathematics-II
3. Scalar and Vector Product: Scalar and vector product of three and four vectors

Course Objectives: The course is aimed

1. To learn the Laplace Transform, Inverse Laplace Transform of various functions and its applications.
2. To understand the concept of Fourier Series, its complex form and enhance the problem solving skill.
3. To understand the concept of complex variables, C-R equations, harmonic functions and its conjugate and mapping in complex plane.
4. To understand the basics of Linear Algebra.
5. To use concepts of vector calculus to analyze and model engineering problems.

Course Outcomes: After successful completion of course student will be able to:

1. Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.
2. Understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic function.
5. Use matrix algebra to solve the engineering problems.
6. Apply the concepts of vector calculus in real life problems.

Module	Detailed Contents	Hrs.
01	Module: Laplace Transform Definition of Laplace transform, Condition of Existence of Laplace transform. Laplace Transform (L) of Standard Functions like e^{at}, $\sin(at)$, $\cos(at)$, $\sinh(at)$, $\cosh(at)$ and $t^n, n \geq 0$. Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by t, Division by t, Laplace Transform of derivatives and integrals (Properties without proof). Evaluation of integrals by using Laplace Transformation. Self-learning Topics: Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.	7
02	Module: Inverse Laplace Transform 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives. 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof). Self-learning Topics: Applications to solve initial and boundary value problems involving ordinary differential equations.	6
03	Module: Fourier Series: 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier series of periodic function with period 2π and $2l$. 3.3 Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series. Self-learning Topics: Complex form of Fourier Series, Orthogonal and orthonormal set of functions. Fourier Transform.	7
04	Module: Complex Variables: 4.1 Function $f(z)$ of complex variable, limit, continuity and differentiability of $f(z)$ Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof). 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof). 4.3 Milne-Thomson method to determine analytic function $f(z)$ when real part (u) or Imaginary part (v) or its combination ($u+v$ or $u-v$) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories Self-learning Topics: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations.	7
05	Module: Linear Algebra: Matrix Theory 5.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors. (Without Proof). 5.2 Cayley-Hamilton theorem (Without proof), Examples based on verification of Cayley-Hamilton theorem and compute inverse of Matrix. 5.3 Similarity of matrices, Diagonalization of matrices. Functions of square matrix Self-learning Topics: Application of Matrix Theory in machine learning and google page rank algorithms, derogatory and non-derogatory matrices.	6
06	Module: Vector Differentiation and Integral 6.1 Vector differentiation: Basics of Gradient, Divergence and Curl (Without Proof). 6.2 Properties of vector field: Solenoidal and irrotational (conservative) vector	6

fields. 6.3 Vector integral: Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation. Self-learning Topics: Gauss' divergence Theorem and applications of Vector calculus.	
Total	39

References:

1. Advanced engineering mathematics, H.K. Das, S . Chand, Publications
2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc-Graw Hill Publication
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics, Wylie and Barret, Tata Mc-Graw Hill.
5. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series
6. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication
7. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1. Attendance (Theory and Tutorial)	05 marks
2. Class Tutorials on entire syllabus	10 marks
3. Mini project	10 marks

Internal Assessment Test (20-Marks):

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Question No: 01 will be compulsory and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. Total 04 questions need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC302	Electronic Devices & Circuits	3	-	--	3	--	--	3

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC302	Electronic Devices & Circuits	20	20	20	80	03	--	--	100

Course pre-requisite:

FEC: 102 - Engineering Physics-I
FEC: 201 - Engineering Physics-II
FEC:105 - Basic Electrical Engineering

Course Objectives:

1. To explain functionality different electronic devices.
2. To perform DC and AC analysis of small signal amplifier circuits.
3. To analyze frequency response of small signal amplifiers.
4. To compare small signal and large signal amplifiers.
5. To explain working of differential amplifiers and it's applications in Operational Amplifiers

Course Outcomes:

After successful completion of the course student will be able to:

1. Know functionality and applications of various electronic devices.
2. Explain working of various electronics devices with the help of V-I characteristics.
3. Derive expressions for performance parameters of BJT and MOSFET circuits.
4. Evaluate performance of Electronic circuits (BJT and MOSFET based).
5. Select appropriate circuit for given application.
6. Design electronic circuit (BJT, MOSFET based) circuits for given specifications.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction of Electronic Devices	05
	1.1	Study of pn junction diode characteristics & diode current equation. Application of zener diode as a voltage regulator.	
	1.2	Construction, working and characteristics of BJT, JFET, and E-MOSFET	
2.0		Biasing Circuits of BJTs and MOSFETs	06
	2.1	Concept of DC load line, Q point and regions of operations, Analysis and design of biasing circuits for BJT (Fixed bias & Voltage divider Bias)	
	2.2	DC load line and region of operation for MOSFETs. Analysis and design of biasing circuits for JFET (self bias and voltage divider bias), E-MOSFET (Drain to Gate bias & voltage divider bias).	
3.0		Small Signal Amplifiers	06
	3.1	Concept of AC load line and Amplification, Small signal analysis (Z_i , Z_o , A_v and A_i) of CE amplifier using hybrid pi model.	
	3.2	Small signal analysis (Z_i , Z_o , A_v) of CS (for E-MOSFET) amplifiers.	
	3.3	Introduction to multistage amplifiers.(Concept, advantages & disadvantages)	
4.0		Frequency response of Small signal Amplifiers:	08
	4.1	Effects of coupling, bypass capacitors and parasitic capacitors on frequency response of single stage amplifier, Miller effect and Miller capacitance.	
	4.2	High and low frequency analysis of CE amplifier.	
	4.3	High and low frequency analysis of CS (E-MOSFET) amplifier.	
5.0		Large Signal Amplifiers:	06
	5.1	Difference between small signal & large signal amplifiers. Classification and working of Power amplifier	
	5.2	Analysis of Class A power amplifier (Series fed and transformer coupled).	
	5.3	Transformer less Amplifier: Class B power amplifier. Class AB output stage with diode biasing	
	5.4	Thermal considerations and heat sinks.	
6.0		Introduction to Differential Amplifiers	08
	6.1	E-MOSFET Differential Amplifier, DC transfer characteristics, operation with common mode signal and differential mode signal	
	6.2	Differential and common mode gain, CMRR, differential and common mode Input impedance.	
	6.3	Two transistor (E-MOSFET) constant current source	
		Total	39

Text books:

1. D. A. Neamen, "Electronic Circuit Analysis and Design," Tata McGraw Hill, 2nd Edition.
2. A. S. Sedra, K. C. Smith, and A. N. Chandorkar, "Microelectronic Circuits Theory and Applications," International Version, OXFORD International Students, 6th Edition
3. Franco, Sergio. Design with operational amplifiers and analog integrated circuits. Vol. 1988. New York: McGraw-Hill, 2002.

References:

1. Boylestad and Nashelesky, "Electronic Devices and Circuits Theory," Pearson Education, 11th Edition.
2. A. K. Maini, "Electronic Devices and Circuits," Wiley.
3. T. L. Floyd, "Electronic Devices," Prentice Hall, 9th Edition, 2012.
4. S. Salivahanan, N. Suresh Kumar, "Electronic Devices and Circuits", Tata Mc-Graw Hill, 3rd Edition
5. Bell, David A. Electronic devices and circuits. Prentice-Hall of India, 1999.

NPTEL/ Swayam Course:

1. Course: Analog Electronic Circuit By Prof. Shouribrata chatterjee (IIT Delhi);
https://swayam.gov.in/nd1_noc20_ee89/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC303	Digital System Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC303	Digital System Design	20	20	20	80	03	--	--	100

Course Pre-requisite:

FEC105 – Basic Electrical Engineering

Course Objectives:

1. To understand number system representations and their inter-conversions used in digital electronic circuits.
2. To analyze digital logic processes and to implement logical operations using various combinational logic circuits.
3. To analyze, design and implement logical operations using various sequential logic circuits.
4. To study the characteristics of memory and their classification.
5. To learn basic concepts in VHDL and implement combinational and sequential circuits using VHDL.

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand types of digital logic, digital circuits and logic families.
2. Analyze, design and implement combinational logic circuits.
3. Analyze, design and implement sequential logic circuits.
4. Develop a digital logic and apply it to solve real life problems.
5. Classify different types of memories and PLDs.
6. Simulate and implement basic combinational and sequential circuits using VHDL/Verilog.

Module No.	Unit No.	Topics	Hrs.
1.0		Number Systems and Codes	04
	1.1	Review of Binary, Octal and Hexadecimal Number Systems, their inter-conversion, Binary code, Gray code and BCD code, Binary Arithmetic, Addition, Subtraction using 1's and 2's Complement	04
2.0		Logic Family and Logic Gates	05
	2.1	Difference between Analog and Digital signals, Logic levels, TTL and CMOS Logic families and their characteristics	03
	2.2	Digital logic gates, Universal gates, Realization using NAND and NOR gates, Boolean Algebra, De Morgan's Theorem	02
3.0		Combinational Logic Circuits	12
	3.1	SOP and POS representation, K-Map up to four variables and Quine-McClusky method for minimization of logic expressions	04
	3.2	Arithmetic Circuits: Half adder, Full adder, Half Subtractor, Full Subtractor, Carry Look ahead adder and BCD adder, Magnitude Comparator	04
	3.3	Multiplexer and De-Multiplexer: Multiplexer operations, cascading of Multiplexer, Boolean function implementation using MUX, DEMUX and basic gates, Encoder and Decoder	04
4.0		Sequential Logic Circuits	12
	4.1	Flip flops: RS, JK, Master slave flip flops; T & D flip flops with various triggering methods, Conversion of flip flops, Registers: SISO, SIPO, PISO, PIPO, Universal Shift Register	04
	4.2	Counters: Asynchronous and Synchronous counters with State transition diagram, Up/Down, MOD N, BCD Counter	04
	4.3	Applications of Sequential Circuits: Frequency division, Ring counter, Johnson counter, Introduction to design of Moore and Mealy circuits	04
5.0		Different Types of Memories and Programmable Logic Devices	04
	5.1	Classification and Characteristics of memory, SRAM, DRAM, ROM, PROM, EPROM and Flash memories	02
	5.2	Introduction: Programmable Logic Devices (PLD), Programmable Logic Array (PLA), Programmable Array Logic (PAL)	02
6.0		Introduction to VHDL	02
	6.1	Basics of VHDL/Verilog Programming, Design and implementation of adder, subtractor, multiplexer and flip flop using VHDL/Verilog	02
		Total	39

Text Books:

1. John F. Warkerly, "Digital Design Principles and Practices", Pearson Education, Fifth Edition (2018).
2. Morris Mano, Michael D. Ciletti, "Digital Design", Pearson Education, Fifth Edition (2013).
3. R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill Education, Forth Edition (2010).
4. A. Anand Kumar, "Fundamentals of Digital Circuits", PHI, Fourth Edition (2016).
5. Volnei A. Pedroni, "Digital Electronics and Design with VHDL" Morgan Kaufmann Publisher, First Edition (2008).
6. Stephen Brown & Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", Third Edition, MGH (2014).

Reference Books:

1. Thomas L. Floyd, "Digital Fundamentals", Pearson Prentice Hall, Eleventh Global Edition (2015).
2. Mandal, "Digital Electronics Principles and Applications", McGraw Hill Education, First Edition (2010).
3. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss "Digital Systems Principles and Applications", Ninth Edition, PHI (2009).
4. Donald P. Leach / Albert Paul Malvino/Gautam Saha, "Digital Principles and Applications", The McGraw Hill, Eight Edition (2015).
5. Stephen Brown & Zvonko Vranesic, "Fundamentals of Digital Logic Design with VHDL", Second Edition, TMH (2009).
6. J. Bhasker, "A Verilog HDL Primer", Star Galaxy Press, Third Edition (1997).

NPTEL / Swayam Course:

1. Course: Digital Circuits By Prof. Santanu Chattopadhyay (IIT Kharagpur);
https://swayam.gov.in/nd1_noc20_ee70/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC304	Network Theory	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. of Test 1 and Test 2					
ECC304	Network Theory	20	20	20	80	03	25	--	125

Course Pre-requisite:

1. FEC105 - Basic Electrical Engineering
2. FEC201 - Engineering Mathematics II

Course Objectives:

1. To evaluate the Circuits using network theorems.
2. To analyze the Circuits in time and frequency domain.
3. To study network Topology, network Functions and two port networks.
4. To synthesize passive network by various methods.

Course Outcomes:

After successful completion of the course student will be able to:

1. Apply their knowledge in analyzing Circuits by using network theorems.
2. Apply the time and frequency method of analysis.
3. Evaluate circuit using graph theory.
4. Find the various parameters of two port network.
5. Apply network topology for analyzing the circuit.
6. Synthesize the network using passive elements.

Module No.	Unit No.	Topics	Hrs.
1.0		Electrical circuit analysis	08
	1.1	Circuit Analysis: Analysis of Circuits with and without dependent sources using generalized loop and node analysis, super mesh and super node analysis technique Circuit Theorems: Superposition, Thevenin's, Norton's and Maximum Power Transfer Theorems (Use only DC source).	
	1.2	Magnetic circuits: Concept of Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit, solution using mesh analysis (for Two Loops only).	
2.0		Graph Theory	06
	2.1	Objectives of graph theory, Linear Oriented Graphs, graph terminologies Matrix representation of a graph: Incidence matrix, Circuit matrix, Cut-set matrix, reduced Incident matrix, Tieset matrix, f-cutset matrix.	
	2.2	Relationship between sub matrices A, B & Q. KVL & KCL using matrix.	
3.0		Time and frequency domain analysis	07
3.0	3.1	Time domain analysis of R-L and R-C Circuits: Forced and natural response, initial and final values. Solution using first order and second order differential equation with step signals.	
	3.2	Frequency domain analysis of R-L-C Circuits: Forced and natural response, effect of damping factor. Solution using second order equation for step signal.	
4.0		Network functions	06
	4.1	Network functions for the one port and two port networks, driving point and transfer functions, Poles and Zeros of Network functions, necessary condition for driving point functions, necessary condition for transfer functions, calculation of residues by graphical methods, testing for Hurwitz polynomial.	
	4.2	Analysis of ladder & symmetrical lattice network (Up to two nodes or loops)	
5.0		Two port Networks	05
	5.1	Parameters: Open Circuits, short Circuit, Transmission and Hybrid parameters, relationship among parameters, conditions for reciprocity and symmetry.	
	5.2	Interconnections of Two-Port networks T & π representation.	
6.0		Synthesis of RLC circuits	07
	6.1	Positive Real Functions: Concept of positive real function, necessary and sufficient conditions for Positive real Functions.	
	6.2	Synthesis of LC, RC & RL Circuits: properties of LC, RC & RL driving point functions, LC, RC & RL network Synthesis in Cauer-I & Cauer-II, Foster-I & Foster-II forms (Up to Two Loops only).	
		Total	39

Textbooks:

1. Franklin F Kuo, "Network Analysis and Synthesis", Wiley Toppan, 2nd ed. ,1966.
2. M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000.

Reference Books:

1. A. Chakrabarti, "*Circuit Theory*", Dhanpat Rai & Co., Delhi, 6th Edition.
2. A. Sudhakar, Shyammohan S. Palli "Circuits and Networks", Tata McGraw-Hill education.
3. Smarajit Ghosh "Network Theory Analysis & Synthesis", PHI learning.
4. K.S. Suresh Kumar, "Electric Circuit Analysis" Pearson, 2013.
5. D. Roy Choudhury, "Networks and Systems" , New Age International, 1998.

NPTEL / Swayam Course:

1. Course: Basic Electrical Circuits By Prof. Nagendra Krishnapura (IIT Madras);
https://swayam.gov.in/nd1_noc20_ee64/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Term Work (25-Marks):

At least **10 assignments** covering entire syllabus must be given during the "**Class Wise Tutorial**". The assignments should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per "**Credit and Grading System**" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC305	Electronic Instrumentation & Control Systems	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC305	Electronic Instrumentation & Control Systems	20	20	20	80	03	--	--	100

Course pre-requisites:

1. FEC105 – Basic Electrical Engineering

Course Objectives:

1. To provide basic knowledge about the various sensors and transducers
2. To provide fundamental concepts of control system such as mathematical modeling, time response and Frequency response.
3. To develop concepts of stability and its assessment criteria.

Course Outcomes:

After successful completion of the course student will be able to:

1. Identify various sensors, transducers and their brief performance specification.
2. Understand the principle of working of various transducer used to measure temperature, displacement, level, pressure and their application in industry
3. Determine the models of physical systems in forms suitable for use in the analysis and design of control systems.
4. Obtain the transfer functions for a given Control system.
5. Understand the analysis of systems in time domain and frequency domain.
6. Predict stability of given system using appropriate criteria.

Module No.	Unit No.	Topics	Hrs.
1		Principle of Measurement, Testing and Measuring instruments	04
	1.1	Introduction to Basic instruments: Components of generalized measurement system Concept of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration.	
	1.2	Measurement of Resistance: Kelvin's double bridge, Wheatstone bridge and Mega ohm bridge Measurement of Inductance: Maxwell bridge and Hey bridge Measurement of Capacitance: Schering bridge	
2		Sensors and Transducers	06
	2.1	Basics of sensors and Transducers-Active and passive transducers, characteristics and selection criteria of transducers	
	2.2	Displacement and pressure- Potentiometers, pressure gauges, linear Variable differential transformers (LVDT) for measurement of pressure and displacement strain gauges	
	2.3	Temperature Transducers- Resistance temperature detectors (RTD). Thermistors and thermocouples, their ranges and applications	
3		Introduction to control system Analysis	08
	3.1	Introduction: Open and closed loop systems, example of control systems	
	3.2	Modelling: Modelling, Transfer function model	
	3.3	Block diagram reduction techniques and Signal flow graph	
4		Response of control system	04
	4.1	Dynamic Response: Standard test signals, transient and steady state behavior of first and second order systems, steady state errors in feedback control systems and their types	
	4.2	Concept of lag and lead compensator.	
5		Stability Analysis in Time Domain	08
	5.1	Concept of stability: Routh and Hurwitz stability criterion	
	5.2	Root locus Analysis: Root locus concept, general rules for constructing root-locus, root locus analysis of control system	
6		Stability Analysis in frequency domain	09
	6.1	Introduction: Frequency domain specification, Relationship between time and frequency domain specification of system, stability margins	
	6.2	Bode Plot: Magnitude and phase plot, Method of plotting Bode plot, Stability margins and analysis using bode plot. Frequency response analysis of RC, RL, RLC circuits	
	6.3	Nyquist Criterion: Concept of Polar plot and Nyquist plot, Nyquist stability criterion, gain and phase margin	
Total			39

Textbooks:

1. A.K. Sawhney, "*Electrical & Electronic Measurement & Instrumentation*" – DRS .India
2. B.C Nakra, K.K. Cahudhary, *Instrumentation Measurement and Analysis*, Tata Mc Graw Hill.
3. W.D. Cooper, "*Electronic Instrumentation And Measuring Techniques*" –PHI
4. Nagrath, M.Gopal, "*Control System Engineering*", Tata McGrawHill.
5. Rangan C. S., Sarma G. R. and Mani V. S. V., "*Instrumentation Devices And Systems*", Tata McGraw-Hill, 2nd Ed.,2004.
6. K.Ogata, "*Modern Control Engineering*, Pearson Education", 3rd edition.

Reference Books:

1. Helfrick&Copper, "*Modern Electronic Instrumentation & Measuring Techniques*" –PHI
2. M.M.S. Anand, "*Electronic Instruments and instrumentation Technology*".
3. Gopal M., "*Control Systems Principles and Design*", Tata McGraw Hill Publishing Co. Ltd.New Delhi, 1998.
4. Benjamin C.Kuo, "*Automatic Control Systems*, Pearson education", 7th edition
5. Doebelin E.D., *Measurement system*, Tata Mc Graw Hill., 4th ed, 2003.Madan Gopal, "*Control Systems Principles and Design*", Tata McGraw hill, 7th edition,1997.
6. Norman, "*Control System Engineering*", John Wiley & sons, 3rd edition.

NPTEL/ Swayam Course:

1. Course: Control Systems By Prof. C. S. Shankar Ram (IIT Madras);
https://swayam.gov.in/nd1_noc20_ee90/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ECL301	Electronic Devices & Circuits Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECL301	Electronic Devices & Circuits Lab	--	--	--	--	25	25	50

Course Objectives:

1. To make students familiar with equipments and measuring instruments used to perform Electronics Devices and Circuits laboratory work.
2. To provide hands on experience to develop laboratory setup for performing given experimental using various equipments, electronic devices and measuring instruments.
3. To develop an ability among students to gather appropriate data and analyse the same to relate theory with practical.
4. To develop trouble shooting abilities among students.

Course Outcomes:

After successful completion of the course students will be able to:

1. Know various equipments, electronics devices and components, and measuring instruments used to perform laboratory work.
2. Students will be able to explain functionality of various equipments, electronics devices and components and neasu6 instruments used to perform laboratory work.
3. Students will be able connect various equipments, devices, components and measuring devices using bread board as per the circuit diagram for experiment to be performed.
4. Students will able to perform experiment to gather appropriate data.
5. Students will able to analyze data obtained from experiment to relate theory with experiment results.
6. Students will able to prepare laboratory report (Journal) to summarise the outcome each experiment.

Laboratory plan:

Maximum of 10 practicals including minimum 2 to 3 simulations should be conducted.
Suggested list of experiments:

1. To study of pn junction diode characteristics.
2. To study zener as a voltage regulator.
3. To study characteristics of CE configuration.
4. To study BJT biasing circuits.
5. To study BJT as CE amplifier.
6. To study frequency response of CE amplifier.
7. To study EMOSFET biasing circuits.
8. Simulation experiment on study of CS amplifier.
9. Simulation experiment on study frequency response of CS amplifier.
10. Simulation experiment on study of differential amplifier.
11. Simulation experiment on multistage amplifier.

Term Work: At least 10 Experiments including not more than 03 simulations covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL302	Digital System Design Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL302	Digital System Design Lab	--	--	--	--	25	--	25

Course objectives:

1. To get familiarise with basic building blocks of Digital System Design and verify the operation of various digital ICs.
2. To train students to design and implementation of combinational circuits.
3. To instruct students on how to design and implement sequential circuits.
4. To introduce simulation software like VHDL/Verilog to design basic digital circuits.

Course outcomes:

Learners will be able to ...

1. Identify various Digital ICs and basic building blocks of digital system design
2. Design and implement combinational circuits like adder, subtractor, multiplexer, code converters etc.
3. Identify and understand working of various types of flip flops and their inter conversions.
4. Design and implement basic sequential circuits such as counters, registers etc.
5. Acquire basic knowledge of VHDL/Verilog basic programming.

Suggested list of experiments:

1. Simplification of Boolean functions.
2. Design AND, OR, NOT, EXOR, EXNOR gates using Universal gates: NAND and NOR.
3. Implement digital circuits to perform Binary to Gray and Gray to Binary operations.
4. Implement Half adder, Full adder, Half subtractor and Full subtractor circuits.
5. Design and implement BCD adder using 4-bit Binary Adder IC-7483.
6. Implement logic equations using Multiplexer.
7. Verify encoder and decoder operations.

8. Design and implement Magnitude Comparator.
9. Verify truth table of different types of flip flops.
10. Flip flop conversions JK to D, JK to T and D to TFF.
11. Design asynchronous/synchronous MOD N counter using IC7490.
12. Verify different counter operations.
13. Write VHDL/Verilog simulation code for different logic gates.
14. Write VHDL/Verilog simulation code for combinational and sequential circuits.
15. Write VHDL/Verilog simulation code for 4:1 Multiplexer, 2 to 4 line binary decoder.

Term Work:

At least 08 experiments covering the entire syllabus must be given “**Batch Wise**”. Out of these, **06 hardware experiments**, to be done strictly on breadboard and **at least 02 software experiments** using VHDL/Verilog. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Pract.	Tut.	Total
ECL303	Electronic Instrumentation & Control Systems Lab.	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical & Oral	Total
		Internal assessment		End Sem. Exam				
ECL303	Electronic Instrumentation & Control Systems Lab.	--	--	--	--	25	--	25

Course Objectives:

1. To experimentally verify the principle and characteristics of various transducers and measurement of resistance and inductance.
2. To make students understand the construction and the working principle of various transducers used for Displacement measurement, Temperature measurement and Level measurement.
3. To examine steady-state and frequency response of the Type 0, 1, and 2 systems.
4. To examine steady-state and frequency response of first and second order electrical systems.
5. To inspect stability analysis of system using Root locus, Bode plot, polar plot and Nyquist plot.

Course Outcomes:

After successful completion of the course student will be able to:

1. Plot and validate the performance characteristics of transducers.
2. Validate the characteristics of various temperature, pressure and level transducers.
3. Plot frequency response of first-order electrical system.
4. Plot time response of second-order electrical system and calculate the steady-state error.
5. Validate the effect of damping factor on the response of second order system.
6. Inspect the frequency response specifications of systems by using bode-plot, Polar plot, Nyquist-plot techniques, and comment on the stability of system

List of experiments:

1. Designing DC bridge for Resistance Measurement (Quarter, Half and Full bridge)
2. Designing AC bridge Circuit for capacitance measurement.
3. Study and characteristics of Resistive Temperature Detector (RTD).
4. Study of Linear Variable Differential Transformer (LVDT)
5. To plot the effect of time constant on first-order systems response.
6. To plot the frequency response of first-order System
7. To plot the time response of second-order systems
8. To plot the frequency response of second-order System
9. To Examine Steady State Error for Type 0, 1, 2 System
10. To study the performance of Lead and Lag Compensator
11. To inspect the relative stability of systems by Root-Locus using Simulation Software.
12. To determine the frequency specification from Polar plot of system
13. To inspect the stability of system by Nyquist plot using Simulation software.
14. To inspect the stability of system by Bode plot using Simulation software.
15. Any other experiment based on syllabus which will help students to understand topic/concept.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments are graded from time to time. The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL304	Skill Lab: C++ and Java Programming	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECL304	Skill Lab: C++ and Java Programming	--	--	--	--	25	25	50

Note: Before performing practical 'Necessary Theory' will be taught by concern faculty

Course Pre-requisites:

1. FEL204 - C-Programming

Course Objectives:

1. Describe the principles of Object Oriented Programming (OOP).
2. To understand object-oriented concepts such as data abstraction, encapsulation, inheritance and polymorphism.
3. Utilize the object-oriented paradigm in program design.
4. To lay a foundation for advanced programming.
5. Develop programming insight using OOP constructs.

Course Outcomes:

After successful completion of the course student will be able to:

1. Describe the basic principles of OOP.
2. Design and apply OOP principles for effective programming.
3. Develop programming applications using OOP language.
4. Implement different programming applications using packaging.
5. Analyze the strength of OOP.
6. Percept the Utility and applicability of OOP.

Module No.	Unit No.	Topics	Hrs.
1.0		C++ Overview	08
	1.1	Need of Object-Oriented Programming (OOP), Object Oriented Programming Paradigm, Basic Concepts of Object-Oriented Programming, Benefits of OOP and C++ as object oriented programming language.	
	1.2	C++ programming Basics, Data Types, Structures, Enumerations, control structures, Arrays and Strings, Class, Object, class and data abstraction, class scope and accessing class members, separating interface from implementation, controlling access to members.	
2.0		C++ Control Structures	08
	2.1	Branching - If statement, If-else Statement, Decision. Looping – while, do-while, for loop Nested control structure - Switch statement, Continue statement, Break statement.	
	2.2	Array - Concepts, Declaration, Definition, Accessing array element, One-dimensional and Multidimensional array.	
3.0		Object-Oriented Programming using C++	12
	3.1	Operator Overloading - concept of overloading, operator overloading, Overloading Unary Operators, Overloading Binary Operators, Data Conversion, Type casting (implicit and explicit), Pitfalls of Operator Overloading and Conversion, Keywords explicit and mutable. Function - Function prototype, accessing function and utility function, Constructors and destructors, Copy Constructor, Objects and Memory requirements, Static Class members, data abstraction and information hiding, inline function. Constructor - Definition, Types of Constructor, Constructor Overloading, Destructor.	
	3.2	Inheritance - Introduction, Types of Inheritance, Inheritance, Public and Private Inheritance, Multiple Inheritance, Ambiguity in Multiple Inheritance, Visibility Modes Public, Private, Protected and Friend, Aggregation, Classes Within Classes. Deriving a class from Base Class, Constructor and destructor in Derived Class, Overriding Member Functions, Class Hierarchies, Polymorphism - concept, relationship among objects in inheritance hierarchy, Runtime & Compile Time Polymorphism, abstract classes, Virtual Base Class.	
4.0		Introduction to Java	06
	4.1	Programming paradigms- Introduction to programming paradigms, Introduction to four main Programming paradigms like procedural, object oriented, functional, and logic & rule based. Difference between C++ and Java.	
	4.2	Java History, Java Features, Java Virtual Machine, Data Types and Size (Signed vs. Unsigned, User Defined vs. Primitive Data Types, Explicit Pointer type), Programming Language JDK Environment and Tools.	
5.0		Inheritance, Polymorphism, Encapsulation using Java	10

	5.1	Classes and Methods: class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value, constructors, this keyword, garbage collection, finalize() method, overloading methods, argument passing, object as parameter, returning objects, access control, static, final, nested and inner classes, command line arguments, variable-length Arguments. String: String Class and Methods in Java.	
	5.2	Inheritances: Member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class. Packages and Interfaces: defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator.	
6.0		Exception Handling and Applets in Java	08
	6.1	Exception Handling: fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exception sub classes). Managing I/O: Streams, Byte Streams and Character Streams, Predefined Streams, Reading console Input, Writing Console Output, and Print Writer class. Threading: Introduction, thread life cycle, Thread States: new, runnable, Running, Blocked and terminated, Thread naming, thread join method, Daemon thread	
	6.2	Applet: Applet Fundamental, Applet Architecture, Applet Life Cycle, Applet Skeleton, Requesting Repainting, status window, HTML Applet tag, passing parameters to Applets, Applet and Application Program.	
		Total	52

Suggested list of Experiments:

Note: Before performing practical necessary Theory will be taught by concern faculty

Sr.No	Write C++ Program to
1	Add Two Numbers
2	Print Number Entered by User
3	Swap Two Numbers
4	Check Whether Number is Even or Odd
5	Find Largest Number Among Three Numbers
6	Create a simple class and object.
7	Create an object of a class and access class attributes
8	Create class methods
9	Create a class to read and add two distance
10	Create a class for student to get and print details of a student.
11	Demonstrate example of friend function with class
12	Implement inheritance.

Sr. No.	Write JAVA Program to
1	Display addition of number
2	Accept marks from user, if Marks greater than 40, declare the student as "Pass" else "Fail"
3	Accept 3 numbers from user. Compare them and declare the largest number (Using if-else statement).
4	Display sum of first 10 even numbers using do-while loop.
5	Display Multiplication table of 15 using while loop.
6	Display basic calculator using Switch Statement.
7	Display the sum of elements of arrays.
8	Accept and display the string entered and execute at least 5 different string functions on it.
9	Read and display the numbers as command line Arguments and display the addition of them
10	Define a class, describe its constructor, overload the Constructors and instantiate its object.
11	Illustrate method of overloading
12	Demonstrate Parameterized Constructor
13	Implement Multiple Inheritance using interface
14	Create thread by implementing 'Runnable' interface or creating 'Thread Class.
15	Demonstrate Hello World Applet Example

Textbooks:

1. Bjarne Stroustrup, "The C++ Programming language", Third edition, Pearson Education.
2. Yashwant Kanitkar, "Let Us Java", 2nd Edition, BPB Publications.
3. D.T. Editorial Services, "Java 8 Programming Black Book", Dreamtech Press, Edition: 2015
4. Deitel, "C++ How to Program", 4th Edition, Pearson Education.

Reference Books:

1. Herbert Schidt, "The Complete Reference", Tata McGraw-Hill Publishing Company Limited, Ninth Edition.
2. Java: How to Program, 8/e, Dietal, PHI.
3. Grady Booch, James Rumbaugh, Ivar Jacobson, "The Unified Modeling Languageser Guide", Pearson Education.
4. Sachin Malhotra, Saurabh Chaudhary "Programming in Java", Oxford University Press, 2010.

Skill-Enhancement:

1. The students should be trained to code in Eclipse (an industry accepted software tool). Also, for a given problem statement, there is need to include external library files (other than JDK files). Moreover, the students need to be trained on Maven (a build tool).
2. Real-life mini-problem statements from software companies (coming in for placement) to be delegated to groups of 3-4 students each and each group to work on the solution for 8-12 hours (last 2 lab sessions).

Software Tools:

1. Raptor-Flowchart Simulation:<http://raptor.martincarlisle.com/>
2. Eclipse: <https://eclipse.org/>
3. Netbeans:<https://netbeans.org/downloads/>
4. CodeBlock:<http://www.codeblocks.org/>
5. J-Edit/J-Editor/Blue J

Online Repository:

1. Google Drive
2. GitHub
3. Code Guru

Term Work:

At least **12** experiments (**06 experiments** each on **C++** and **JAVA**) covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam should cover all **12** experiments for examination.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM301	Mini Project 1A	--	04 ^{\$}	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM301	Mini Project 1A	--	--	--	--	25	25	50

\$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: At the end of the course learners will be able to...

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
 - Marks awarded by guide/supervisor based on log book : 10
 - Marks awarded by review committee : 10
 - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
 - First shall be for finalisation of problem
 - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
 - First review is based on readiness of building working prototype to be conducted.
 - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
 - Identification of need/problem
 - Proposed final solution
 - Procurement of components/systems
 - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
 - First shall be for finalisation of problem and proposed solution
 - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
 2. Clarity of Problem definition based on need.
 3. Innovativeness in solutions
 4. Feasibility of proposed problem solutions and selection of best solution
 5. Cost effectiveness
 6. Societal impact
 7. Innovativeness
 8. Cost effectiveness and Societal impact
 9. Full functioning of working model as per stated requirements
 10. Effective use of skill sets
 11. Effective use of standard engineering norms
 12. Contribution of an individual's as member or leader
 13. Clarity in written and oral communication
- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
 - In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

NOTE: For Electronics & Telecommunication Engineering we recommend following syllabus for Mini-Project 1A, in case it is half-year project.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM301	Mini Project 1A: Analog & Digital Circuit Design based Projects	--	04\$	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM301	Mini Project 1A: Analog & Digital Circuit Design based Projects	--	--	--	--	25	25	50

\$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Course Pre-requisite:

1. FEC105 - BEE

Course Objectives:

1. To make students familiar with the basics of electronic devices and circuits, electrical circuits and digital systems
2. To familiarize the students with the designing and making of Printed circuit boards(PCB)
3. To improve the knowledge of electronics hardware among students

Course outcomes:

After successful completion of the course student will be able to:

1. Create the electronics circuit for particular application/experiment.
2. Design and simulate the circuits by putting together the analog and digital components
3. Learn the technique of soldering and circuit implementation on general purpose printed circuit board (GPP).
4. Realize the PCB design process and gain up-to-date knowledge of PCB design software.
5. Utilize the basic electronic tools and equipment's (like DMM, CRO, DSO etc.)
6. Analysis of hardware fault (Fault detection and correction)

Module No.	Unit No.	Topics	Hrs.
1.0		Identification and Designing of Circuit	08
	1.1	Identification of particular application with understanding of its detail operation. Study of necessary components and devices required to implement the application.	
	1.2	Designing the circuit for particular application (either analog , digital, electrical , analog and digital, etc)	
2.0		Software simulation and Implementation on GPP	12
	2.1	Simulation of circuit for particular application using software's to verify the expected results	
	2.2	Implementation of verified circuit on general purpose printed circuit board (GPP). Now Verify the hardware results by using electronic tools and equipment's like millimeter, CRO, DSO etc.	
3.0		PCB design and optimization	08
	3.1	Design the circuit by placing components using PCB design software's.	
	3.2	Reduce the size of PCB by varying the position of components or devices for optimize use of copper clad material	
4.0		Implementation of PCB	08
	4.1	Transfer the designed PCB on Copper clad either by using dark room or taking printout on glossy paper, etc (use available suitable method).	
	4.2	Perform Etching and then Soldering.	
5.0		Detection of Hardware faults and Result verification	08
	5.1	Identify the hardware faults in designed circuit and subsequently rectify it	
	5.2	Now again verify the hardware results by using electronic tools and equipment's like millimeter, CRO, DSO etc.	
6.0		Understanding the Troubleshooting	08
	6.1	Understand the trouble shooting by removing some wired connection.	
	6.2	Understand the trouble shooting of track. Troubleshoot the faculty components or devices	
		Total	52

NOTE: During 1st week or within 1-month of the beginning of the semester, following topics related to ADC and DAC should be covered as theoretical concepts.

- Performance specifications of ADC, single ramp ADC, ADC using DAC, dual slope ADC, successive approximation ADC.**
- Performance specifications of DAC, binary weighted resistor DAC, R/2R ladder DAC, inverted R/2R ladder DAC.**

Reference books:

- Schultz Mitchel E., "*Grob's Basic Electronics*", McGraw-Hill Education; 10th edition, 25 October , 2006.
- Charles Platt, "*Make Electronics: Learning by discovery*", O'Reilly; 2nd edition, 18 September , 2015.
- Forrest M Mims III, "*Getting started in Electronics*", Book Renter, Inc.; 3rd edition , 1 January 2000.

4. R S Khandpur, "*Printed circuit board*", McGraw-Hill Education; 1st edition, 24 February , 2005.
5. Kraig Mitzner, "*Complete PCB Design Using OrCAD Capture and PCB Editor*", Academic Press; 2nd edition , 20 June 2019.

Suggested Software tools:

1. LTspice: <https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html#>
2. Eagle : <https://www.autodesk.in/products/eagle/overview>
3. OrCAD: <https://www.orcad.com/>
4. Multisim : <https://www.multisim.com/>
5. Webbench: <http://www.ti.com/design-resources/design-tools-simulation/webench-power-designer.html>
6. Tinkercad : <https://www.tinkercad.com/>

Online Repository:

1. <https://www.electronicsforu.com>
2. <https://circuitdigest.com>
3. <https://www.electronicshub.org>

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	TW/Pract	Tut.	Total
ECC401	Engineering Mathematics-IV	03	-	01*	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Exam Duration (in Hrs.)	Term Work	Pract & Oral	Total
		Internal Assessment			End Sem exam				
		Test1	Test2	Avg. of Test 1 & 2					
ECC401	Engineering Mathematics-IV	20	20	20	80	03	25	-	125

* Should be conducted batch wise.

Pre-requisite:

1. FEC101-Engineering Mathematics-I
2. FEC201-Engineering Mathematics-II
3. ECC301-Engineering Mathematics-III & Binomial Distribution.

Course Objectives: The course is aimed:

1. To understand line and contour integrals and expansion of complex valued function in a power series.
2. To understand the basic techniques of statistics for data analysis, Machine learning and AI.
3. To understand probability distributions and expectations.
4. To understand the concepts of vector spaces used in the field of machine learning and engineering problems.
5. To understand the concepts of Quadratic forms and Singular value decomposition.
6. To understand the concepts of Calculus of Variations.

Course Outcomes:

On successful completion of course learner/student will be able to:

1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
2. Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning and AI.
3. Apply the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
4. Apply the concept of vector spaces and orthogonalization process in Engineering Problems.
5. Use the concept of Quadratic forms and Singular value decomposition which are very useful tools in various Engineering applications.
6. Find the extremals of the functional using the concept of Calculus of variation.

Module	Detailed Contents	Hrs.
01	Module: Complex Integration 1.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 1.2 Taylor's and Laurent's series (without proof). 1.3 Definition of Singularity, Zeroes, poles of $f(z)$, Residues, Cauchy's Residue Theorem (without proof). Self-learning Topics: Application of Residue Theorem to evaluate real integrations, Z- Transform.	7
02	Module: Statistical Techniques 2.1 Karl Pearson's Coefficient of correlation (r) . 2.2 Spearman's Rank correlation coefficient (R) (repeated and non-repeated ranks) 2.3 Lines of regression. 2.4 Fitting of first and second degree curves. Self-learning Topics: Covariance, fitting of exponential curve.	6
03	Module: Probability Distributions 1.1 Baye's Theorem, Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function. 3.2 Expectation, mean and variance. 3.3 Probability distribution: Poisson & normal distribution. Self-learning Topics: Moments, Moment Generating Function, Applications of Probability Distributions in Engineering.	7
04	Module: Linear Algebra: Vector Spaces:- 4.1 Vectors in n-dimensional vector space, norm, dot product, The CauchySchwarz inequality (with proof), Unit vector. 4.2 Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors. 4.3 Vector spaces over real field, subspaces. Self-Learning Topics:- Linear combinations, linear Dependence and Independence, QR decomposition.	6
05	Module: Linear Algebra: Quadratic Forms 5.1 Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation. 5.2 Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value-class of a quadratic form-Definite, Semidefinite and Indefinite. 5.3 Reduction of Quadratic form to a canonical form using congruent transformations. 5.4 Singular Value Decomposition. Self-learning Topics: Orthogonal Transformations, Applications of Quadratic forms and SVD in Engineering.	7

06	Module: Calculus of Variations: 6.1 Euler- Lagrange equation (Without Proof), When F does not contain y, When F does not contain x, When F contains x, y, y'. 6.2 Isoperimetric problems- Lagrange Method. 6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method. Self-Learning Topics:- Brachistochrone Problem, Variational Problem, Hamilton Principle, Principle of Least action , Several dependent variables.	6
Total		39

References:

1. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
3. Advanced engineering mathematics H.K. Das, S . Chand, Publications.
4. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication
- 5 Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
6. Advanced Engineering Mathematics Wylie and Barret, Tata Mc-Graw Hill.
7. Beginning Linear Algebra Seymour Lipschutz Schaum's outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Term Work (25-Marks):

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Internal Assessment Test (25-Marks):

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Question No: 01 will be compulsory and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. Total 04 questions need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC402	Micro-controllers	3	-	--	3	-	--	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC402	Micro-controllers	20	20	20	80	03	-	-	100

Course Pre-requisites:

1. ECC303 - Digital System Design

Course objectives:

1. To develop background knowledge of Computer and its memory System.
2. To understand architecture of 8051 and ARM7 core.
3. To write programs for 8051 microcontrollers.
4. To understand design of Microcontroller Applications.

Course outcomes:

After successful completion of the course student will be able to:

1. Understand Computer and its memory System,
2. Understand the detailed architecture of 8051 and ARM7 Core.
3. Write programs for 8051 microcontrollers.
4. Design an applications using microcontroller.

Module No.	Unit No.	Topics	Hrs
1		Overview of Microprocessor based System	5
	1.1	Overview of microcomputer systems and their building blocks, Memory Interfacing, Steps taken by the microprocessor to fetch and executes an instruction from the memory	
	1.2	Concepts of Program counter register, Reset, Stack and stack pointer , Subroutine, Interrupts and Direct Memory Access	
	1.3	Concept of RISC & CISC Architecture	
	1.4	Harvard & Von Neumann Architecture	
2		The Memory Systems	4
	2.1	Classification of Memory : Primary and Secondary	
	2.2	Types of Semiconductor memories	
	2.3	Cache Memory	
	2.4	Virtual Memory Concept with Memory Management Unit with Segmentation and Paging (Address Translation Mechanism)	
3		8051 Microcontroller	8
	3.1	Comparison between Microprocessor and Microcontroller	
	3.2	Features, architecture and pin configuration	
	3.3	CPU timing and machine cycle	
	3.4	Input / Output ports	
	3.5	Memory organization	
	3.6	Counters and timers	
	3.7	Interrupts	
	3.8	Serial data input and output	
4		8051 Assembly Language Programming and Interfacing	9
	4.1	Addressing modes	
	4.2	Instruction set	
	4.3	Need of Assembler & Cross Assemble, Assembler Directives	
	4.4	Programs related to: arithmetic, logical, delay subroutine , input, output, timer, counters, port, serial communication, and interrupts	
	4.5	Interfacing with LEDs, Relay and Keys	
5		ARM7	8
	5.1	Introduction & Features of ARM 7	
	5.2	Concept of Cortex-A, Cortex-R and Cortex-M	
	5.3	Architectural inheritance, Pipelining	
	5.4	Programmer's model	
	5.5	Brief introduction to exceptions and interrupts handling	
	5.6	Instruction set: Data processing, Data Transfer, Control flow	
6		Study 8 bit microcontroller Applications	5
	6.1	Understanding features of NXP 89v51RD2, Atmega 328P and PIC16F886	
	6.2	Selecting a microcontroller for an application	
	6.3	Study of 89v51 based Clock Using I2C RTC and Seven Segment Display	
	6.4	PIC16F886 Speed Control of DC Motor.	
	6.5	Atmega 328P based remote temperature monitoring with LCD display	
Total			39

Text Books:

1. Douglas V Hall, SSSP Rao "Microprocessors & Interfacing", McGraw Hill
2. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, "Computer Organization", Fifth Edition, Tata McGraw-Hill
3. Shibu K. V "Introduction to embedded systems" McGraw Hill.
4. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, "The 8051 Microcontroller & Embedded systems", Pearson Publications, Second Edition 2006.
5. C. Kenneth J. Ayala and D. V. Gadre, "The 8051 Microcontroller & Embedded system using assembly & 'C' ", Cengage Learning, Edition 2010.
6. Steve Furber, "ARM System on chip Architecture", Pearson, 2nd edition.

Reference books:

1. "MCS@51 Microcontroller, Family User's Manual" Intel
2. "PIC16F882/883/884/886/887 Data Sheet", Microchip.
3. ATmega328P 8-bit AVR Microcontroller with 32K Bytes In-System Programmable Flash datasheet, Atmel
4. P89V51RB2/RC2/RD2 8-bit 80C51 5 V low power 16/32/64 kB flash microcontroller, Data Sheet NXP founded by Philips
5. James A. Langbridge, "Professional Embedded Arm Development", Wrox, John Wiley Brand & Sons Inc., Edition 2014

NPTEL/ Swayam Course:

1. Course: Microprocessors and Microcontrollers By Prof. Santanu Chattopadhyay (IIT Kharagpur);
https://swayam.gov.in/nd1_noc20_ee42/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC403	Linear Integrated Circuits	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs)	Term Work	Prac. and Oral	Total
		Internal assessment			End Sem. Exam. (ESE)				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC403	Linear Integrated Circuits	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. FEC105-Basic Electrical Engineering
2. ECC302-Electronic Devices & Circuits

Course Objectives:

1. To understand the concepts, working principles and key applications of linear integrated circuits.
2. To perform analysis of circuits based on linear integrated circuits.
3. To design circuits and systems for particular applications using linear integrated circuits.

Course Outcome:

After successful completion of the course student will be able to:

1. Outline and classify all types of integrated circuits.
2. Understand the fundamentals and areas of applications for the integrated circuits.
3. Develop the ability to design practical circuits that perform the desired operations.
4. Understand the differences between theoretical & practical results in integrated circuits.
5. Identify the appropriate integrated circuit modules for designing engineering application.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Operational Amplifier	07
	1.1	Block diagram of Op-Amp. Ideal and practical characteristics of op-amp.	
	1.2	Configurations of Op-Amp: Open loop and closed loop configurations of Op-amp, Inverting and Non-inverting configuration of Op-amp and buffer.	
	1.3	Summing amplifier, difference amplifiers and Instrumentation amplifier using Op-amp.	
2.0		Linear Applications of Operational Amplifier	08
	2.1	Voltage to current and current to voltage converter.	
	2.2	Integrator & differentiator (ideal & practical), Active Filters: First and Second order active low pass, high pass, band pass, band reject and Notch filters.	
	2.3	Positive feedback, Barkhausen's criteria, Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.	
3.0		Non-Linear Applications of Operational Amplifier	07
3.0	3.1	Comparators: Inverting comparator, non-inverting comparator, zero crossing detectors, window detector.	
	3.2	Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.	
	3.3	Waveform Generators: Square wave generator and triangular wave generator. Basics of Precision Rectifiers: Half wave and full wave precision rectifiers. Peak detector.	
4.0		Timer IC 555 and it's applications	07
	4.1	Functional block diagram and working of IC 555	
	4.2	Design of Astable and Monostable multivibrator using IC 555	
	4.3	Applications of Astable and Monostable multivibrator as Pulse width modulator and Pulse Position Modulator.	
5.0		Voltage Regulators.	06
	5.1	Functional block diagram, working and design of three terminal fixed voltage regulators (78XX, 79XX series).	
	5.2	Functional block diagram, working and design of general purpose IC 723 (HVLC and HVHC).	
	5.3	Introduction and block diagram of switching regulator, Introduction of LM 317.	
6.0		Special Purpose Integrated Circuits	04
	6.1	Functional block diagram and working of VCO IC 566 and application as frequency modulator.	
	6.2	Functional block diagram and working of PLL IC 565 and application as FSK Demodulator.	
		Total	39

Textbooks:

1. Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits", Pearson Prentice Hall, 4th Edition.
2. D. Roy Choudhury and S. B. Jain, "Linear Integrated Circuits", New Age International Publishers, 4th Edition.

Reference Books:

1. K. R. Botkar, "Integrated Circuits", Khanna Publishers (2004)
2. Sergio Franco, "Design with operational amplifiers and analog integrated circuits", Tata McGraw Hill, 3rd Edition.
3. David A. Bell, "Operation Amplifiers and Linear Integrated Circuits", Oxford University Press, Indian Edition.
4. R. F. Coughlin and F. F. Driscoll, "Operation Amplifiers and Linear Integrated Circuits", Prentice Hall, 6th Edition.
5. J. Millman, Christos CHalkias, and Satyabratatajit, Millman's, "Electronic Devices and Circuits," McGrawHill, 3rd Edition.

NPTEL/ Swayam Course:

1. Course: ICs MOSFETs Op-Amps & Their Applications By Prof. Hardik Jeetendra Pandya (IISc Bangalore);
https://swayam.gov.in/nd1_noc20_ee13/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC404	Signals and Systems	03	--	01	03	--	01	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 & Test 2					
ECC404	Signals and Systems	20	20	20	80	03	25	--	125

Course pre-requisite:

1. ECC301 – Engineering Mathematics III

Course objectives:

1. To introduce students to the idea of signal and system analysis and characterization in time and frequency domain.
2. To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.

Course outcomes:

After successful completion of the course student will be able to:

1. Classify and Analyze different types of signals and systems
2. Analyze continuous time LTI signals and systems in transform domain
3. Analyze and realize discrete time LTI signals and systems in transform domain
4. Represent signals using Fourier Series and Analyze the systems using the Fourier Transform.
5. Demonstrate the concepts learnt in Signals and systems Course using the modern engineering tools.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to signals and systems	07
	1.1	Introduction to Signals: Definition, Basic Elementary signals - exponential, sine, step, impulse, ramp, rectangular, triangular. Operations on signals. Classification of Signals: analog and discrete time signals, even and odd signals, periodic and non-periodic signals, deterministic and non-deterministic signals, energy and power signals.	
	1.2	Systems and Classification of systems: System Representation, continuous time and discrete systems, system with and without memory, causal and non-causal system, linear and nonlinear system, time invariant and time variant system, stable system.	
2.0		Time domain analysis of Continuous Time and Discrete Time systems	07
	2.1	Linear Time Invariant (LTI) systems: Representation of systems using differential /difference equation, Impulse, step and exponential response, System Stability and Causality.	
	2.2	Use of convolution integral and convolution sum for analysis of LTI systems, properties of convolution integral/sum, impulse response of interconnected systems.	
	2.3	Correlation and spectral Density: auto-correlation, cross correlation, analogy between correlation and convolution, energy spectral density, power spectral density, relation of ESD and PSD with auto-correlation.	
3.0		Fourier Analysis of Continuous and Discrete Time Signals and Systems	07
	3.1	Fourier transform of periodic and non-periodic functions, Properties of Fourier Transform, Inverse Fourier Transform, Frequency Response: computation of Magnitude and Phase Response, Limitations of Fourier Transform.	
4.0		Laplace Transform and Continuous time LTI systems	06
	4.1	Need of Laplace Transform, Concept of Region of Convergence, Properties of Laplace Transform, Relation between continuous time Fourier Transform and Laplace Transform, unilateral Laplace Transform, inverse Laplace Transform.	
	4.2	Analysis of continuous time LTI systems using Laplace Transform: Causality and stability of systems in s-domain, Total response of a system.	
5.0		z-Transform and Discrete time LTI systems	08
	5.1	Need of z-Transform, z-Transform of finite and infinite duration sequences, Concept of Region of Convergence, z-Transform	

		properties, Standard z-transform pairs, relation between z-transform and discrete time Fourier Transform, one sided z-Transform. Inverse z-Transform: Partial Fraction method only.	
	5.2	Analysis of discrete time LTI systems using z-Transform: Systems characterized by Linear constant coefficient difference equation, Transfer Function, plotting Poles and Zeros of a transfer function, causality and stability of systems, Total response of a system.	
6.0		FIR and IIR systems	04
	6.1	Concept of finite impulse response systems and infinite impulse response systems, Linear Phase FIR systems.	
	6.2	Realization structures of LTI system: Direct form –I and direct form II, Linear Phase FIR structures.	
Total			39

Text books:

1. Nagoor Kani, Signals and Systems, Tata McGraw Hill, Third Edition, 2011.
2. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, Signals and Systems, Pearson Education, Fourth Edition 2009.
3. Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, Signals and Systems, Prentice-Hall of India, Second Edition, 2002.
4. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.

Reference books:

- 1) Hwei. P Hsu, Signals and Systems, Tata McGraw Hill, Third edition, 2010
- 2) Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.
- 3) V. Krishnaveni and A. Rajeshwari, Signals and Systems, Wiley-India, First Edition 2012.
- 4) Michael J Roberts, Fundamentals of Signals and systems, Tata McGraw Hill, special Indian Economy edition, 2009.
- 5) Luis F. Chaparro, Signals and Systems Using MATLAB, Academic Press
- 6) Rangaraj M. Rangayyan, "Biomedical Signal Analysis- A Case Study Approach", Wiley 2002.
- 7) Signals and Systems Laboratory: Virtual Laboratory <http://ssl-iitg.vlabs.ac.in/>

NPTEL/ Swayam Course:

1. Course: Principles of Signals & Systems By Prof. Aditya K. Jagannatham (IIT Kanpur); https://swayam.gov.in/nd1_noc20_ee15/preview

Teachers and students are encouraged to use *Signals and Systems Laboratory: Virtual Laboratory* (Reference number 8) for demonstration of concepts such as systems and their properties, Fourier analysis etc.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Term Work (25-Marks):

At least 06 Tutorials covering entire syllabus and 01 course project must be given during the "Class Wise Tutorial".

Students can form team of maximum 4 members and work on course project using any software viz. C, Python, Scilab, Matlab, Octave, etc. The course project should be appropriately selected in order to demonstrate any concept learnt in this course.

03-hours (out of the total 12-hours allotted for the tutorials) can be utilized for the course project completion.

Term work assessment must be based on the overall performance of the student with every tutorial and a course project graded from time to time. The grades will be converted to marks as per "Credit and Grading System" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC405	Principles of Communication Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Prac. & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC405	Principles of Communication Engineering	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. ECC301 - Engineering Mathematics- III
2. ECC302 - Electronic Devices and Circuits

Course Objectives:

1. To illustrate the fundamentals of basic communication system.
2. To understand various analog modulation and demodulation techniques.
3. To focus on applications of analog modulation and demodulation techniques.
4. To explain the key concepts of analog and digital pulse modulation and demodulation techniques.

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand the basic components and types of noises in communication system.
2. Analyze the concepts of amplitude modulation and demodulation.
3. Analyze the concepts of angle modulation and demodulation.
4. Compare the performance of AM and FM receivers.
5. Describe analog and digital pulse modulation techniques.
6. Illustrate the principles of multiplexing and demultiplexing techniques.

Module No.	Unit No.	Topics	Hours
1		Basics of Communication System	05
	1.1	Block diagram, electromagnetic spectrum, signal bandwidth and power, types of communication channels, Introduction to time and frequency domain. Basic concepts of wave propagation.	03
	1.2	Types of noise, signal to noise ratio, noise figure, noise temperature and Friss formula.	02
2		Amplitude Modulation and Demodulation	12
	2.1	Basic concepts, need for modulation, waveforms (time domain and frequency domain), modulation index, bandwidth, voltage distribution and power calculations.	04
	2.2	DSBFC: Principles, low-level and high-level transmitters, DSB suppressed carrier, Balanced modulators with diode (Ring modulator and FET) and SSB systems.	04
	2.3	Amplitude demodulation: Diode detector, practical diode detector, Comparison of different AM techniques, Applications of AM and use of VSB in broadcast television.	04
3		Angle Modulation and Demodulation	10
	3.1	Frequency and Phase modulation (FM and PM): Basic concepts, mathematical analysis, FM wave (time and frequency domain), sensitivity, phase and frequency deviation, modulation index, deviation ratio, bandwidth requirement of angle modulated waves, narrowband FM and wideband FM.	04
	3.2	Varactor diode modulator, FET reactance modulator, stabilized AFC, Direct FM transmitter, indirect FM Transmitter, noise triangle, pre- emphasis and de-emphasis	03
	3.3	FM demodulation: Balanced slope detector, Foster-Seely discriminator, Ratio detector, FM demodulator using Phase lock loop, amplitude limiting and thresholding, Applications of FM and PM.	03
4		Radio Receivers	04
	4.1	Characteristics of radio receivers, TRF, Super - heterodyne receiver block diagram, tracking and choice of IF, AGC and its types and Communication receiver.	03
	4.2	FM receiver block diagram, comparison with AM receiver.	01
5		Analog and Digital Pulse Modulation & Demodulation	06
	5.1	Sampling theorem for low pass signal, proof with spectrum, Nyquist criteria, Sampling techniques, aliasing error and aperture effect.	03
	5.2	PAM, PWM, PPM generation, detection and applications. Basics of PCM system and differential PCM system. Concepts of Delta modulation (DM) and Adaptive Delta Modulation (ADM).	03
6		Multiplexing & De-multiplexing	02
	6.1	Frequency Division Multiplexing transmitter & receiver block diagram and applications. Time Division Multiplexing transmitter & receiver block diagram and applications.	02
		Total	39

Textbooks:

1. Kennedy and Davis, "Electronics Communication System", Tata McGraw Hill, Fourth edition.
2. B.P. Lathi, Zhi Ding "Modern Digital and Analog Communication system", Oxford University Press, Fourth edition.
3. Wayne Tomasi, "Electronics Communication Systems", Pearson education, Fifth edition.

Reference Books:

1. Taub, Schilling and Saha, "Taub's Principles of Communication systems", Tata McGraw Hill, Third edition.
2. P. Sing and S.D. Sapre, "Communication Systems: Analog and Digital", Tata McGraw Hill, Third edition.
3. Simon Haykin, Michel Moher, "Introduction to Analog and Digital Communication", Wiley, Second edition.
4. Dennis Roddy and John Coolen, Electronic Communication, Pearson, 4/e, 2011.
5. Louis Frenzel, "Communication Electronics", Tata McGraw Hill, Third Edition.

NPTEL/ Swayam Course:

1. Course: Analog Communication By Prof. Goutam Das (IIT Kharagpur);
https://swayam.gov.in/nd1_noc20_ee69/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-1). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL401	Micro-controllers Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL401	Micro-controllers Lab	-	-	-	-	-	25	--	25

Course Objectives:

1. To understand development tools of microcontroller based systems.
2. To learn programming for different microcontroller operation & interface to I/O devices.
3. To develop microcontroller based applications.

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand different development tools required to develop microcontroller based systems.
2. Write assembly language programs for arithmetic and logical operations, code conversion & data transfer operations.
3. Write assembly language programs for general purpose I/O, Timers & Interrupts.
4. Interface & write programs for Input and Output devices
5. Develop microcontroller based Applications.

Suggested Experiment List:

1. Perform Arithmetic and Logical Operations (Using Immediate, Direct and Indirect addressing)
2. Code Conversion
3. Transfer of data bytes between Internal and External Memory
4. Experiments based on General Purpose Input-Output, Timers, Interrupts, Delay, etc
5. Interfacing of Matrix Key board, LED, 7 Segment display, LCD, Stepper Motor, UART

At Least 10 experiment Minimum two from each category of above list must be given during the **Laboratory session batch wise**. Computation/simulation based experiments are also encouraged.

Before starting the experiments there should be one session on Study of development tools like Editor, Assembler-cross Assembler, Compiler-Cross compiler, Linker, Simulator, emulator etc.

Mini project based on 8051 derivatives, PIC, AVR & other 8 bit microcontrollers using Assembly and/or C language. (Readymade of Arduino & raspberry pi are **not recommended here**)

Note: Mini Project can be considered as a part of term-work.

Term Work (25-Marks):

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per “**Choice Based Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL402	Linear Integrated Circuits Lab.	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ECL402	Linear Integrated Circuits Lab.	--	--	--	--	--	25	25	50

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand the differences between theoretical, practical and simulated results in integrated circuits.
2. Apply the knowledge to do simple mathematical operations.
3. Apply knowledge of op-amp, timer and voltage regulator ICs to design simple applications.

Laboratory Plan:

Minimum 8 hardware practical (compulsorily based on IC 741, IC 555, IC 723 and remaining on VCO 566 or PLL 565) and 2 simulations should be conducted. At least one experiment from each Module of syllabus.

Suggested list of experiments:

1. Design inverting, non-inverting amplifier and buffer using IC 741.
2. Design summing and difference amplifier using op-amp.
3. Design voltage to current converter with grounded load.
4. Design and analyze Integrator
5. Design and analyze Differentiator
6. Design Schmitt trigger using Op-amp.
7. Design Wein bridge and RC phase shift Oscillator.
8. Design and analyze second order High pass and Low pass filter
9. Design and analyze Band pass and Band reject filter.
10. Design Astable multivibrator using IC 555 for fixed frequency and variable duty cycle.
11. Design Monostable Multivibrator using IC 555.
12. Design Low voltage Low current voltage regulator using IC 723.
13. Design High voltage High current voltage regulator using IC 723.
14. Design Frequency Modulator using IC 566
15. Design FSK Demodulator using IC 565
16. Design Instrumentation amplifier using 3 Op-Amp.
17. Design Precision rectifier
18. Design Square & Triangular wave generator

Term Work (25-Marks):

At least 10 Experiments including 02 simulations covering entire syllabus must be given during the "Laboratory session batch wise". Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time.

The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL403	Principles of Communication Engineering Lab.	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL403	Principles of Communication Engineering Lab.	--	--	--	--	--	25	25	50

Course Pre-requisites:

1. Usage of basic Electronic instruments and components.
2. Fundamentals of Electronic Devices and circuits

Course Objectives:

1. To give an understanding of Time and Frequency domain representation of signals.
2. To demonstrate continuous wave modulation and demodulation.
3. To demonstrate analog and digital pulse communication.
4. Able to use simulation software to build communication circuits.

Course Outcomes:

After successful performance of the practicals student will be able to:

1. Analyze analog modulation techniques.
2. Analyze the waveforms of Radio receivers.
3. Implement analog pulse modulation and demodulation circuits.
4. Demonstrate digital pulse modulation and demodulation techniques.
5. Verify the concepts of TDM and FDM.

Suggested list of Experiments:

Sr. No	Title
1	Generation of AM modulation and demodulation.
2	Analyze waveforms at various stages of SSB system.
3	Generation of FM modulation and demodulation.
4	Analyze the output waveforms of each block of AM transmitter /receiver
5	Analyze the output waveforms of each block of FM transmitter /receiver
6	Design and implement Pre-emphasis and De-emphasis circuit.
7	Verification of sampling theorem.
8	Generation of PAM modulation and demodulation.
9	Generation of PWM and PPM modulation and demodulation.
10	Demonstrate Digital pulse transmission technique (PCM)
11	Demonstrate Digital pulse transmission technique (DM,ADM)
12	Observation of TDM multiplexing and de-multiplexing signals.
13	Observation of FDM multiplexing and de-multiplexing signals.

Term Work (25-Marks):

At least **10** experiments (**07 hardware experiments and at least 03 software experiments**) covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and application oriented. Signal should be analyzed in time and frequency domain.

Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all 10 experiments for examination.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL404	Skill Lab: Python Programming	-	04	--	--	02	--	02

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECL404	Skill Lab: Python Programming	-	-	-	-	25	25	50

NOTE: Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

Course pre-requisite:

1. ECL304 – Skill Lab: C++ and Java Programming.

Course Objectives:

1. Describe the core syntax and semantics of Python programming language.
2. Explore file handling in Python
3. Infer the Object-oriented Programming concepts in Python
4. Formulate GUI Programming and Databases operations in Python
5. Develop applications using variety of libraries and functions

Course Outcomes:

After successful completion of the course student will be able to:

1. Describe syntax and semantics in Python
2. Illustrate different file handling operations
3. Interpret object oriented programming in Python
4. Design GUI Applications in Python
5. Express proficiency in the handling Python libraries for data science
6. Develop machine learning applications using Python

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Python	6
	1.1	Introduction to Python, Installation and resources, Identifiers and Keywords, Comments, Indentation and Multi-lining, Variables (Local and Global), data types, Arithmetic, Comparative, Logical and Identity Operators, Bitwise Operators, Expressions, Print statement and Formats, Input Statements in python	
	1.2	Strings, Lists, Tuples, Dictionaries, Sets, Accessing Elements, Properties, Operations and methods on these data structures.	
	1.3	Decision Flow Control Statement: if and else statement, Nested If statement, Loop Statement: While Loop, do and while loop, for loop statement, Continue, Break and pass Statement, Conditional Statements	
2.0		Functions and File I/O Handling	8
	2.1	Functions: Built-in-functions, library functions, Defining and calling the functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions, Modules and importing packages in python code.	
	2.2	File Input/Output: Files I/O operations, Read / Write Operations, File Opening Modes, <i>with</i> keywords, Moving within a file, Manipulating files and directories, OS and SYS modules.	
3.0		Object Oriented Programming	9
	3.1	Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes.	
	3.2	Intricacies of Classes and Objects, Inheritance, Constructor in Inheritance, Exception Handling, Link list, Stack, Queues.	
4.0		Graphical User Interface and Image processing	9
	4.1	Graphical User Interface using Tkinter Library module, creating simple GUI; Buttons, Labels, entry fields, widget attributes.	
	4.2	Database: Sqlite database connection, Create, Append, update, delete records from database using GUI.	
	4.3	Basic Image Processing using OpenCV library, simple image manipulation using image module.	
5.0		Numpy, Pandas, Matplotlib, Seaborn, Scipy	10
	5.1	Introduction to Numpy, Creating and Printing Narray, Class and Attributes of Narray, Basic operation, Copy and view, Mathematical Functions of Numpy.	
	5.2	Introduction to Pandas, Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation.	
	5.3	Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn.	
	5.4	Introduction to Scipy, Scipy Sub packages – Integration and Optimization, Eigen values and Eigen Vectors, Statistic, Weave and IO.	
6.0		Python Applications	10
	6.1	GUI based applications	
	6.2	Applications in Image Processing, Networking	
	6.3	Machine Learning, Linear Regression, Logistic Regression	
	6.4	Classification using K nearest neighbor,	
	6.5	Support Vector Machines	
Total			52

Text Books:

1. Yashavant Kanetkar, "Let us Python: Python is Future, Embrace it fast", BPB Publications; 1 edition (8 July 2019).
2. Dusty Phillips, "Python 3 object-oriented Programming", Second Edition PACKT Publisher August 2015.
3. John Grayson, "Python and Tkinter Programming", Manning Publications (1 March 1999).
4. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
5. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
6. Introduction to computing and problem solving using python , E Balagurusamy, McGraw Hill Education.
7. Zed A. Shaw, "Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code", Addison Wesley; 3 edition (1 October 2013).

Reference Books:

1. Eric Matthes, "Python Crash Course A hands-on, Project Based Introduction to programming" No Starch Press; 1 edition (8 December 2015).
2. Paul Barry, "Head First Python" O'Reilly; 2 edition (16 December 2016)
3. Andreas C. Mueller, "Introduction to Machine Learning with Python", O'Reilly; 1 edition (7 October 2016)
4. David Beazley, Brian K. Jones, "Python Cookbook: Recipes for Mastering Python 3", O'Reilly Media; 3 edition (10 May 2013).
5. Bhaskar Chaudhary, "Tkinter GUI Application Development Blueprints: Master GUI programming in Tkinter as you design, implement, and deliver 10 real world application", Packt Publishing (November 30, 2015)

Software Tools:

1. Python IDE: <https://www.python.org/downloads/>
2. Anaconda Environment: <https://www.anaconda.com/distribution/>

Online Repository:

1. Github
2. Python 3 Documentation: <https://docs.python.org/3/>
3. "The Python Tutorial", <http://docs.python.org/release/3.0.1/tutorial/>
4. <http://spoken-tutorial.org>
5. Python 3 Tkinter library Documentation: <https://docs.python.org/3/library/tk.html>
6. Numpy Documentation: <https://numpy.org/doc/>
7. Pandas Documentation: <https://pandas.pydata.org/docs/>
8. Matplotlib Documentation: <https://matplotlib.org/3.2.1/contents.html>
9. Scipy Documentation : <https://www.scipy.org/docs.html>
10. Machine Learning Algorithm Documentation: <https://scikit-learn.org/stable/>
11. <https://nptel.ac.in/courses/106/106/106106182/>

The following list of experiments and course project is for illustration purpose. Faculty members are required to introduce their own innovative list of experiments based on above curriculum.

Sr. No.	Problem Statement	Module No.
1.	1. Write python programs to understand expressions, variables, quotes, basic math operations, list, tuples, dictionaries, arrays etc. 2. Write Python program to implement byte array, range, set and different STRING Functions (len, count, lower, sorted etc) 3. Write Python program to implement control structures.	Module 1

	4. Assume a suitable value for distance between two cities (in km). Write a program to convert and print this distance in meters, feet, inches and centimetre. 5. Write a program to carry out the following operations on the given set $s = \{10, 2, -3, 4, 5, 88\}$ - Number of items in sets s - Maximum element in sets s - Minimum element in sets s - Sum of all elements in sets s - Obtain a new sorted set from s, set s remaining unchanged - Report whether 100 is an element of sets s - Report whether -3 is not an element of sets s.	
2.	1. Write python program to understand different File handling operations 2. Create 3 lists – a list of names, a list of ages and a list of salaries. Generate and print a list of tuples containing name, age and salary from the 3lists. From this list generate 3 tuples – one containing all names, another containing all ages and third containing all salaries.	Module 2
3.	1. Write Python program to implement classes, object, Static method and inner class 2. If any integer is given as in input through the keyboard, write a program to find whether it is odd or even number. 3. If ages of Ram, Shyam, and Ajay are given as an input through the keyboard, write a program to determine the youngest of the three. 4. Write a program that prints square root and cube root of numbers from 1 to 10, up to 4 decimal places. Ensure that the output is displayed in separate lines, with number center-justified and square and cube roots right-justified. 5. Write a program to find the factorial value of any number entered through the keyboard. 6. Write a program that defines a function count_lower_upper() that accepts a string and calculates the number of uppercase and lowercase alphabets in it. It should return these values as a dictionary. Call this function for some sample strings. 7. A 5-digit positive integer is entered through the keyboard, write a recursive function to calculate sum of digits of 5-digit number.	Module 3
4.	1. Write Python program to create, append, update, delete records from database using GUI. 2. Write Python program to obtain histogram of any image 3. Write Python Program to split color image in R,G,B and obtain individual histograms. 4. Write Python program for histogram equalization 5. Write Python Program for edge detection 6. Write Python Program for image segmentation 7. Write Python program to implement GUI Canvas application using Tkinter 8. Write Python program to implement GUI Frame application using Tkinter	Module 4
5.	1. Write Python program to study define, edit arrays and perform arithmetic operations. 2. Write python program to study selection, indexing, merging, joining, concatenation in data frames 3. Evaluate the dataset containing the GDPs of different countries to: - Find and print the name of the country with the highest GDP - Find and print the name of the country with the lowest GDP - Print text and input values iteratively	Module 5

	d. Print the entire list of the countries with their GDPs e. Print the highest GDP value, lowest GDP value, mean GDP value, standardized GDP value, and the sum of all the GDPs 4. Analyze the Federal Aviation Authority (FAA) dataset using Pandas to do the following: a. View: aircraft make name, state name, aircraft model name, text information, flight phase, event description type, b. fatal flag c. b. Clean the dataset and replace the fatal flag NaN with "No". d. c. Find the aircraft types and their occurrences in the dataset e. d. Remove all the observations where aircraft names are not available f. Display the observations where fatal flag is "Yes" 5. Analyze the "auto mpg data" and draw a pair plot using seaborn library for mpg, weight, and origin. (a) Origin: This dataset was taken from the StatLib library maintained at Carnegie Mellon University. • Number of Instances: 398 • Number of Attributes: 9 including the class attribute • Attribute Information: • mpg: continuous • cylinders: multi-valued discrete • displacement: continuous • horsepower: continuous • weight: continuous • acceleration: continuous • model year: multi-valued discrete • origin: multi-valued discrete • car name: string (unique for each instance) 5. Write python program to use SciPy to solve a linear algebra problem. 6. There is a test with 30 questions worth 150 marks. The test has two types of questions: 1. True or false – carries 4 marks each 2. Multiple-choice – carries 9 marks each. Find the number of true or false and multiple-choice questions.	
6.	1. Write python program to study linear regression 2. Write python program to study multiple linear regression 3. Write python program to study logistic regression 4. Write python program to study Support Vector Machine 5. Write python program to study decision tree algorithm 6. Write python program to study two-way communication between client and server. 7. Write Python Program to study image morphological operations.	Module 6

Suggested list of course projects:

- Speed typing Test using Python
- Music player in Python
- Calculator app using tkinter
- Train announcement system using python
- Dice rolling simulator
- Expense tracker
- Contact book using python
- Develop classification model using freely available datasets
- Develop python application for sentiment analysis

Note:

1. Use of free cloud service such as Google Colab to run python scripts is encouraged.
2. Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

Term Work (25-Marks):

At least **12 experiments and 01 course project** should be performed. Term work assessment must be based on the overall performance of the student with every experiment and project graded from time-to-time. The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM401	Mini Project 1B	--	04 ^{\$}	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM401	Mini Project 1B	--	--	--	--	25	25	50

\$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: At the end of the course learners will be able to...

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
 - Marks awarded by guide/supervisor based on log book : 10
 - Marks awarded by review committee : 10
 - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
 - First shall be for finalisation of problem
 - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
 - First review is based on readiness of building working prototype to be conducted.
 - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
 - Identification of need/problem
 - Proposed final solution
 - Procurement of components/systems
 - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
 - First shall be for finalisation of problem and proposed solution
 - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
 2. Clarity of Problem definition based on need.
 3. Innovativeness in solutions
 4. Feasibility of proposed problem solutions and selection of best solution
 5. Cost effectiveness
 6. Societal impact
 7. Innovativeness
 8. Cost effectiveness and Societal impact
 9. Full functioning of working model as per stated requirements
 10. Effective use of skill sets
 11. Effective use of standard engineering norms
 12. Contribution of an individual's as member or leader
 13. Clarity in written and oral communication
- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
 - In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

NOTE: For Electronics & Telecommunication Engineering we recommend following syllabus for Mini-Project 1B, in case it is half-year project.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM401	Mini-Project 1B: Arduino & Raspberry Pi based Projects	-	04 ^{\$}	--	--	02	--	02

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECM401	Mini-Project 1B: Arduino & Raspberry Pi based Projects	-	-	-	-	25	25	50

\$ indicates work load of Learner (Not Faculty), for Mini Project 1B. Faculty Load: 1 hour per week per four groups.

Course pre-requisite:

1. ECM301 – Mini-Project 1A
2. ECL304 – C++ and Java Programming
3. ECC302 – Electronic Devices and Circuit

Course Objectives:

1. To make students familiar with the basics of Electronics, Microcontroller, Arduino board, Raspberry Pi, Arduino IDE (Integrated Development Environment) and Python programming.
2. To familiarize the students with the programming and interfacing of different devices with Arduino and Raspberry Pi Board.
3. To increase students critical thinking ability and provide solutions to some real time problems.

Course Outcomes:

After successful completion of the course student will be able to

1. Write basic codes for the Arduino board using the IDE for utilizing the onboard resources.
2. Apply the knowledge of interfacing different devices to the Arduino board to accomplish a given task.
3. Design Arduino based projects for a given problem.
4. Write code using python language using IDE for utilizing the onboard resources.
5. Apply the knowledge of interfacing different devices to raspberry Pi board to accomplish a given task.
6. Design Raspberry Pi based projects for a given problem.

Experiment No.	Unit No.	Section A: Arduino Board	Hrs.
EX.1.0		Introduction to Arduino Board	02
	1.1	Introduction to Arduino Uno board and integrated development environment (IDE	
	1	Write the code for blinking the on board led with a specified delay Apparatus Requirement: Hardware: Arduino Board LED, Software: Arduino IDE Software.	
EX.2.0		GPIO (along with Analog pin) Programming	04
	2.1	Introduction to programming GPIO, Analog and PWM PINS.	
	1	Interface any Digital Sensors to the Arduino board and display sensor values on serial Monitor.	
	2	Interface any Analog sensor to the Arduino board and display sensor values on serial Monitor.	
	3.	Generate varying duty cycle PWM using Arduino.	
EX.3.0		Controlling output devices/Displaying	04
	3.1	Introduction to different sensor (Analog and Digital), Relays, Motors and display.	
	1	Interface an Analog Sensors to the Arduino board and display sensor values on LCD/TFT/Seven segment Display.	
	2	Interface a temperature sensor to Arduino and switch on a relay to operate a fan if temperature exceeds given threshold. Also display the temperature on any of the display device	
EX.4.0		Interfacing Communication Devices and Cloud Networking	04
	4.1	Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.	
	1	Interface Wi-Fi /Bluetooth/GSM/Zigbee/RF module to Arduino and program it to transfer sensor data wirelessly between two devices. Any two techniques from the above-mentioned modules needs to be interfaced.	
5.0		Sample Projects	10
	1.	Waste Management System	
	2.	Smart City Solutions	
	3.	Energy Monitoring Systems	
	4.	Smart Classrooms and learning Solutions	
	5.	Home security systems	
	6.	Smart Agriculture solutions	
	7.	Healthcare solutions.	
	8.	Industrial Applications	
	9.	IoT Applications	
	10.	Robotics	
Section 'A' Total Hrs.			24

Experiment No.	Unit No.	Section B: Raspberry Pi	Hrs.
EX.1.0		Introduction to Raspberry PI	02
	1.1	What is Raspberry PI? Downloading and Installation of NOOBS, First Power-Up & Having a Look around, Introduction to the Shell and Staying updated.	
	1	Familiarization with Raspberry PI and perform necessary software installation. Apparatus Requirement: Hardware: Raspberry PI Board, Memory of 16GB, Power adapter, Memory Writer. Software: NOOBS, Raspbian OS, Win32 disk Imager, SD-Formatter software.	

EX.2.0		Interfacing with Input / Output Devices using Python	04
	2.1	Introduction to Python, Connecting to the outside World with GPIO.	
	1	To Interface LED/Buzzer with Raspberry PI and write a program to turn ON LED for 1 sec after every 2 sec. Apparatus Requirement: Raspberry PI with inbuilt Python Package, LED, Buzzer.	
	2	To interface Push Button / Digital Sensor (IR/LDR) with Raspberry PI and write a program to turn ON LED when Push button is pressed or at sensor detection. Apparatus Requirement: Raspberry PI with inbuilt Python Package, Push Button Switch, Digital Sensor (IR/LDR).	
	3.	To interface analog sensor using MCP 3008 analog to digital converter chip. Apparatus Requirement: Raspberry PI with inbuilt Python Package, analog sensor, MCP 3008 chip.	
EX.3.0		Interfacing Temperature Sensor, Motors, Display Devices.	04
	3.1	Introduction to Temperature sensor (Analog and Digital), Relays, Motors (DC, Stepper) and Driver circuits.	
	1	To interface DHT11 sensor with Raspberry PI and write a program to print temperature and humidity readings. Apparatus Requirement: Raspberry PI with inbuilt Python Package, DTH11 Sensor.	
	2	To interface motor using relay with Raspberry PI and write a program to turn ON motor when push button is pressed. Apparatus Requirement: Raspberry PI with inbuilt Python Package, Relays, Motor Driver, Motors.	
	3	To interface OLED with Raspberry PI and write a program to print temperature and humidity readings on it. Apparatus Requirement: Raspberry PI with inbuilt Python Package, OLED display device.	
EX.4.0		Interfacing Communication Devices and Cloud Networking	04
	4.1	Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.	
	1	To interface Bluetooth/Zigbee/RFID/WiFi with Raspberry PI and write a program to send sensor data to smartphone using Bluetooth/Zigbee/RFID/WIFI. (Any one can be used for performing) Apparatus Requirement: Raspberry PI with inbuilt Python Package, Bluetooth/Zigbee/RFID/WIFI.	
	2	Introduction to Cloud computing, different types cloud networks and interconnection using Raspberry PI	
	3	Write a program on Raspberry PI to upload temperature and humidity data from thingspeak cloud. Apparatus Requirement: Raspberry PI with inbuilt Python Package, Cloud networks such as thingspeak (open source), AWS, Azure, etc. anyone can be used for understanding purpose and building projects.	
EX.5.0		Understanding of Communication Protocols	04
	5.1	Introduction to MQTT, IFTTT protocols and configuration steps.	
	1	Write a program on Raspberry PI to publish temperature data to MQTT broker	
	2	Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it.	
	3	Configuration of Webserver using Raspberry PI.	
6.0		Sample Projects	10
	1.	MQTT Based Raspberry Pi Home Automation: Controlling Raspberry Pi GPIO using MQTT Cloud	
	2.	License Plate Recognition using Raspberry Pi and OpenCV	
	3.	Real Time Face Recognition with Raspberry Pi and OpenCV	
	4.	Smart Garage Door Opener using Raspberry Pi	

5.	Remote Controlled Car Using Raspberry Pi and Bluetooth	
6.	Fingerprint Sensor based door locking system using Raspberry Pi	
7.	Raspberry Pi Ball Tracking Robot using Processing	
8.	Web Controlled Home Automation using Raspberry Pi	
9.	Line Follower Robot using Raspberry Pi	
10.	Raspberry Pi based Smart Phone Controlled Home Automation	
11.	Web Controlled Raspberry Pi Surveillance Robotic Car	
12.	Raspberry Pi Based Weight Sensing Automatic Gate	
13.	Raspberry Pi Emergency Light with Darkness and AC Power Line Off Detector	
14.	Detecting Colors using Raspberry Pi and Color Sensor TCS3200	
15.	Measure Distance using Raspberry Pi and HCSR04 Ultrasonic Sensor	
16.	Call and Text using Raspberry Pi and GSM Module	
17.	Raspberry Pi Home Security System with Email Alert	
18.	Raspberry Pi Based Obstacle Avoiding Robot using Ultrasonic Sensor	
19.	Web Controlled Notice Board using Raspberry Pi	
20.	RF Remote Controlled LEDs Using Raspberry Pi	
21.	RFID and Raspberry Pi Based Attendance System	
22.	Raspberry Pi Interactive Led-Mirror	
23.	Garage Door monitor using Raspberry Pi	
24.	Raspberry Pi Digital Code Lock on Breadboard	
25.	Electronic Voting Machine using Raspberry Pi	
Section 'B' Total Hrs.		28
Total A + B		52

Reference Books:

1. Simon Monk, "Hacking Electronic: Learning Arduino and Raspberry Pi", McGraw-Hill Education TAB; 2 edition (September 28, 2017)
2. Simon Monk, "Raspberry Pi Cookbook Software and Hardware Problems and Solutions" O'Reilly 2nd Edition
3. Simon Monk, Programming the Raspberry Pi, 2nd Edition: Getting Started with Python" The McGraw Hill
4. "DK Workbooks: Raspberry Pi Project Workbook", DK Children; Workbook edition (March 7, 2017)
5. Donald Norris, "Raspberry Pi Electronic Projects for Evil Genius", McGraw-Hill Education TAB; 1 edition (May 20, 2016)

Software Tools:

1. Raspbian OS: <https://www.raspberrypi.org/downloads/>
2. Win32 Disk Imager: <https://sourceforge.net/projects/win32diskimager/>
3. SD Card Formatter: <https://www.sdcard.org/downloads/formatter/>
4. Arduino IDE: <https://www.arduino.cc/en/main/software>

Online Repository:

1. GitHub
2. NPTEL Videos on Raspberry Pi and Arduino Programming
3. <https://www.electronicsforu.com/raspberry-pi-projects>
4. <https://circuitdigest.com/simple-raspberry-pi-projects-for-beginners>
5. <https://www.electronicshub.org/raspberry-pi-projects/>

6. Spoken Tutorial Project-IIT Bombay: https://spoken-tutorial.org/tutorial-search/?search_foss=Arduino&search_language=English
7. Teachers are recommended to use a free online simulation platform “Tinkercad” for the simulation of Arduino based circuits before the students implement it in the hardware: <https://www.tinkercad.com/>

UNIVERSITY OF MUMBAI



Bachelor of Engineering

in

Mechanical Engineering

Second Year with effect from AY 2020-21

Third Year with effect from AY 2021-22

Final Year with effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC 23/07/2020Item No. 119

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	Second Year B.E. in Mechanical Engineering
2	Eligibility for Admission	After Passing First Year Engineering as per the Ordinance 0.6242
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	Ordinance 0.6242
5	No. of Years / Semesters	8 semesters
6	Level	P.G. / U.G. / ~~Diploma~~ / ~~Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / Semester (Strike out which is not applicable)
8	Status	New / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	From Academic Year: 2020-2021

Date

Dr. S. K. Ukarande

Associate Dean

Faculty of Science and Technology

University of Mumbai

University of Mumbai

Dr Anuradha Muzumdar

Dean

Faculty of Science and Technology

University of Mumbai

B. E. (Mechanical Engineering), Rev 2019 2

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C ‘ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A’ and ‘B’ respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

When the entire world is discussing about ‘Industry 4.0’, we are at the crossroads. There are so many expectations from the graduating engineers, who shall be the major contributors to ecosystem for development of the Nation. Engineering education in India, in general, is being revamped so as to impart the theoretical knowledge along with industrial exposure. It is our attempt, when we are introducing a new curriculum; to bridge the industry-academia gap. To enable this, we have introduced components such as skill-based laboratories and project-based learning. We trust that this will allow the learner to apply knowledge gained in previous and current semesters to solve problems for gaining better understanding. What once were pure mechanical systems have now been transformed into multidisciplinary systems of mechatronics, electronics and computer science. Interdisciplinary knowledge is gaining importance as we are moving towards automated world as technology advances. Keeping this in mind the curriculum has been designed in a way so that learner shall be acquainted with many Interdisciplinary subjects.

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. The Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by several faculty members and Industry experts. The Program Educational Objectives proposed for the undergraduate program in Mechanical Engineering are listed below:

1. To prepare the stake holder to exhibit leadership qualities with demonstrable attributes in lifelong learning to contribute to the societal needs.
2. To make ready the stake holder to pursue higher education for professional development
3. To help the stake holder to acquire the analytical and technical skills, knowledge, analytical ability attitude and behavior through the program
4. To prepare the stakeholders with a sound foundation in the mathematical, scientific and engineering fundamentals
5. To motivate the learner in the art of self-learning and to use modern tools for solving real life problems and also inculcate a professional and ethical attitude and good leadership qualities
6. To prepare the stake holder to able to Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

We trust this revised version of syllabus come up to the expectations of all stakeholders. We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar	: Chairman
Dr. S. M. Khot	: Member
Dr. V. M. Phalle	: Member
Dr. Siddappa Bhusnoor	: Member
Dr. S.S. Pawar	: Member
Dr. Sanjay U. Bokade	: Member
Dr. Dhanraj Tambuskar	: Member

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract .	Tut.	Theory	Pract.	Tut.	Total
MEC301	Engineering Mathematics-III	3	--	1	3	--	1	4
MEC302	Strength of Materials	3		--	3		--	3
MEC303	Production Processes	4	--	--	4	--	--	4
MEC304	Materials and Metallurgy	3	--	--	3	--	--	3
MEC305	Thermodynamics	3	--	--	3	--	--	3
MEL301	Materials Testing	--	2	--	--	1	--	1
MEL302	Machine Shop Practice	--	4	--	--	2	--	2
MESBL301	CAD –Modeling	--	4	--	--	2	--	2
MEPBL301	Mini Project – 1A	--	4 ^{\$}	--	--	2	--	2
Total		16	14	1	16	07	1	24

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg .					
MEC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
MEC302	Strength of Materials	20	20	20	80	3	--	--	100
MEC303	Production Processes	20	20	20	80	3	--	--	100
MEC304	Materials and Metallurgy	20	20	20	80	3	--	--	100
MEC305	Thermodynamics	20	20	20	80	3	--	--	100
MEL301	Materials Testing	--	--	--	--	--	25	25	50
MEL302	Machine Shop Practice	--	--	--	--	--	50	--	50
MESBL301	CAD – Modeling	--	--	--	--	--	25	25	50
MEPBL301	Mini Project – 1A	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	150	75	725

\$ indicates work load of Learner (Not Faculty), for Mini Project

SBL – Skill Based Laboratory

PBL – Project Based Learning

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
MEC401	Engineering Mathematics-IV	3	--	1	3	--	1	4
MEC402	Fluid Mechanics	3	--	--	3	--	--	3
MEC403	Kinematics of Machinery	3	--	--	3	--	--	3
MEC404	CAD/CAM	3	--	--	3	--	--	3
MEC405	Industrial Electronics	3	--	--	3	--	--	3
MEL401	Industrial Electronics	--	2	--	--	1	--	1
MEL402	Kinematics of Machinery	--	2	--	--	1	--	1
MEL403	Python Programming	--	2	--	--	1	--	1
MESBL401	CNC and 3-D Printing	--	4	--	--	2	--	2
MEPBL401	Mini Project – 1B	--	4 ^{\$}	--	--	2	--	2
Total		15	14	1	15	7	1	23

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
MEC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
MEC402	Fluid Mechanics	20	20	20	80	3	--	--	100
MEC403	Kinematics of Machinery	20	20	20	80	3	--	--	100
MEC404	CAD/CAM	20	20	20	80	3	--	--	100
MEC405	Industrial Electronics	20	20	20	80	3	--	--	100
MEL401	Industrial Electronics	--	--	--	--	--	25	25	50
MEL402	Kinematics of Machinery	--	--	--	--	--	25	--	25
MEL403	Python Programming	--	--	--	--	--	25	25	50
MESBL401	CNC and 3-D Printing	--	--	--	--	--	25	25	50
MEPBL401	Mini Project – 1B	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	150	100	750

\$ indicates work load of Learner (Not Faculty), for Mini Project

SBL – Skill Based Laboratory

PBL – Project Based Learning

Students group and load of faculty per week.

Mini Project 1A / 1B: Students can form groups with minimum 2 (Two) members and not more than 4 (Four) members

Faculty Load: 1 hour per week per four groups

Course Code	Course Name	Credits
MEC301	Engineering Mathematics-III	4

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II,

Objectives: The course is aimed

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills
3. To familiarize with the concept of complex variables, C-R equations with applications.
4. To study the application of the knowledge of matrices and numerical methods in complex engineering problems.

Outcomes: On successful completion of course learner/student will be able to:

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.
6. Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations

Module	Detailed Contents	Hrs.
01	Module: Laplace Transform 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform, 1.2 Laplace Transform (L) of Standard Functions like e^{at}, $\sin(at)$, $\cos(at)$, $\sinh(at)$, $\cosh(at)$ and t^n, where $n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by t, Division by t, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation. Self-learning topics: Heaviside's Unit Step function, Laplace Transform. of Periodic functions, Dirac Delta Function.	07
02	Module: Inverse Laplace Transform 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivative 2.2 Partial fractions method & first shift property to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) Self-learning Topics: Applications to solve initial and boundary value problems involving ordinary differential equations.	06

03	Module: Fourier Series: 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof) 3.2 Fourier series of periodic function with period 2π and $2l$, 3.3 Fourier series of even and odd functions 3.4 Half range Sine and Cosine Series. Self-learning Topics: Complex form of Fourier Series, orthogonal and orthonormal set of functions, Fourier Transform.	07
04	Module: Complex Variables: 4.1 Function $f(z)$ of complex variable, limit, continuity and differentiability of $f(z)$, Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof), 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof) 4.3 Milne-Thomson method to determine analytic function $f(z)$ when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories Self-learning Topics: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations	07
05	Module: Matrices: 5.1 Characteristic equation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors. (No theorems/ proof) 5.2 Cayley-Hamilton theorem (without proof): Application to find the inverse of the given square matrix and to determine the given higher degree polynomial matrix. 5.3 Functions of square matrix 5.4 Similarity of matrices, Diagonalization of matrices Self-learning Topics: Verification of Cayley Hamilton theorem, Minimal polynomial and Derogatory matrix & Quadratic Forms (Congruent transformation & Orthogonal Reduction)	06
06	Module: Numerical methods for PDE 6.1 Introduction of Partial Differential equations, method of separation of variables, Vibrations of string, Analytical method for one dimensional heat and wave equations. (only problems) 6.2 Crank Nicholson method 6.3 Bender Schmidt method Self-learning Topics: Analytical methods of solving two and three dimensional problems.	06

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S.R.K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics, H.K. Das, S. Chand Publication
5. Higher Engineering Mathematics B.V. Ramana, McGraw Hill Education
6. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education,
7. Text book of Matrices, Shanti Narayan and P K Mittal, S. Chand Publication
8. Laplace transforms, Murray R. Spiegel, Schaum's Outline Series

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/111/104/111104085/>
2. <https://nptel.ac.in/courses/111/106/111106139/>

Course Code	Course Name	Credits
MEC302	Strength of Materials	03

Objectives:

1. To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres subjected to various types of simple loads.
2. To calculate the elastic deformation occurring in various simple geometries for different types of Loading.
3. To study distribution of various stresses in the mechanical elements under different types of loads.

Outcomes: Learner will be able to...

1. Demonstrate fundamental knowledge about various types of loading and stresses induced.
2. Draw the SFD and BMD for different types of loads and support conditions.
3. Analyse the bending and shear stresses induced in beam.
4. Analyse the deflection in beams and stresses in shaft.
5. Analyse the stresses and deflection in beams and Estimate the strain energy in mechanical elements.
6. Analyse buckling phenomenon in columns.

Module	Detailed Contents	Hrs
1.	Introduction-Concept of Stress Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses, Stress Strain Diagram, elastic constants and their relations- volumetric, linear and shear strains. Composite sections, Thermal stress and strain. Principal stresses and Principal planes- Mohr's circle. Moment of inertia about an axis and polar moment of inertia	08
2.	Shear Force and Bending Moment in Beams: Introduction to types of beams, supports and loadings. Definition of bending moment and shear force, Sign conventions, relationship between load intensity, bending moment and shear force. Shear force and bending moment diagrams for statically determinate beams subjected to points load, uniformly distributed loads, uniformly varying loads, couple and their combinations.	06
3.	Stresses in Beams: Theory of bending of beams, bending stress distribution, shear stress distribution for point and distributed loads in simply supported and over-hanging beams, cantilevers.	08
4.	Deflection of Beams: Deflection of a beam: Double integration method, Maxwell's reciprocal theorems for computation of slopes and deflection in beams for point and distributed loads. Torsion: Stresses in solid and hollow circular shafts.	06

5.	Thin Cylindrical and Spherical Shells: Stresses and deformation in Thin Cylindrical and Spherical Shells subjected to internal pressure Strain Energy: Strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to bending and torsion.	06
6.	Columns: Buckling load, Types of end conditions for column, Euler's column theory and its limitations and Rankine formula.	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

References:

1. Strength of Materials by Ryder, Macmillan
2. Mechanics of Materials by James M. Gere and Barry J. Goodno, Cengage Learning, 6thEd, 2009
3. Mechanics of Materials by Gere and Timoshenko, CBS 2nd Edition
4. Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East -West Press
5. Mechanics of Materials by Beer, Johnston, Dewolf and Mazurek, TMHPvt Ltd., New Delhi
6. Mechanics of Structures by S.B.Junnarkar, Charotar Publication
7. Mechanics of Materials by S.S.Ratan, Tata McGraw Hill Pvt. Ltd
8. Introduction to Solid Mechanics by Shames, PHI
9. Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
10. Strength of Materials by W.Nash, Schaum's Outline Series, McGraw Hill Publication, Special Indian Edition
11. Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016

Links for online NPTEL/SWAYAM courses:

1. <http://www.nptelvideos.in/2012/11/strength-of-materials-prof.html>
2. https://swayam.gov.in/nd1_noc20_ce34

Course Code	Course Name	Credits
MEC303	Production Processes	04

Objectives:

1. To familiarize with the various production processes used on shop floors
2. To study appropriate production processes for a specific application.
3. To introduce to the learner various machine tools used for manufacturing
4. To familiarize with principle and working of non-traditional manufacturing
5. To introduce to them the Intelligent manufacturing in the context of Industry 4.0

Outcomes: Learner will be able to....

1. Demonstrate an understanding of casting process
2. Illustrate principles of forming processes.
3. Demonstrate applications of various types of welding processes.
4. Differentiate chip forming processes such as turning, milling, drilling, etc.
5. Illustrate the concept of producing polymer components and ceramic components.
6. Illustrate principles and working of non-traditional manufacturing
7. Understand the manufacturing technologies enabling Industry 4.0

Module	Details	Hrs.
1	Introduction to Production Processes and Metal Casting 1.1. Classification of Production Processes and applications areas 1.2. Pattern making materials, Types of pattern and allowances. 1.3. Sand moulding and Machine moulding 1.4. Gating system :Types of riser, types of gates, solidification 1.5. Special casting processes : CO2 and shell moulding, Investment casting, Die casting, Vacuum casting, Inspection & casting defects and remedies	09
2	Joining Processes 2.1. Classification of various joining processes; Applicability, advantages and limitations of Adhesive bonding, Mechanical Fastening; Welding and allied processes, Hybrid joining processes. 2.2. Classification and Working of various welding methods: Gas, Arc, Chemical, Radiant, Solid State etc. 2.3. Welding Joints, Welding Positions, Welding defects and their remedies.	09
3	3.1. Forming processes • Introduction and classification of metalworking processes, hot and cold working processes • Introduction, classification and analysis of forging and rolling operations, Defects in rolled and forged components, • Extrusion process, Classification and analysis of wire and tube drawing processes. 3.2. Sheet metal working processes • Classification of Sheet metal operations, types of Presses used in sheet metal operations, types of dies.	09

4	4.1. Machine Tools, Machining Processes. • Machine Tools and Machining Processes: Lathe Machines, Milling Machines, Drilling Machines, and Grinding Machines and selection of grinding wheel (Dressing and Truing), Broaching machines, Lapping/Honing machines (Super Finishing Operations) and shaping/slotting/planning Machines. • Gear Manufacturing Gear milling, standard cutters and limitations, Gear Hobbing, Gear Shaping, Gear Shaving and Gear Grinding processes 4.2. Tool Engineering • Geometry and nomenclature of single point cutting tool, Speed, feed, depth of cut, Taylor's tool life equation, Concept of chip formation and types of chips. Introduction to Jigs and Fixtures and types.	12
5	5.1 Non Traditional Machining Processes: • Electro-chemical machining (ECM) • Electric-discharge machining (EDM) • Ultrasonic machining (USM) • Laser Beam Machining (LBM)	05
6.	6.1 Polymer Processing: • Polymer Molding Techniques for thermoplastic and thermosetting plastics. Applications of Plastics in engineering field. 6.2 Powder Metallurgy: • Introduction to PM, Powder making processes, Steps in PM. Compaction and Sintering processes. Secondary and finishing operations in PM. 6.3 Intelligent manufacturing in the context of Industry 4.0, • Cyber-physical systems (CPS) • Internet of Things (IoT) enabled manufacturing • Cloud Manufacturing	08

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

References:

1. Welding technology by O P Khanna
2. Foundry technology by O P Khanna
3. Elements of workshop technology. Vol. 1 & II by S K HajraChoudhury
4. Manufacturing Science by Ghosh and Malik
5. Rapid Manufacturing –An Industrial revolution for the digital age by N.Hopkinson, R.J.M.Hauge, P M, Dickens, Wiley
6. Rapid Manufacturing by Pham D T and Dimov, Springer Verlag
7. Production Technology by WAJ Chapman Vol I, II, III
8. Production Technology by P C Sharma.
9. Production Technology by Raghuvanshi.
10. Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, 2016, Apress.
11. Cyber-Physical Systems: From Theory to Practice by Danda B. Rawat, Joel Rodrigues, Ivan Stojmenovic, 2015, C.R.C. Press.
12. Optimization of Manufacturing Systems using Internet of Things by Yingfeng Zhang, Fei Tao, 2017, Academic Press (AP), Elsevier.

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/112/107/112107219/>
2. <https://nptel.ac.in/courses/112/107/112107215/>
3. <https://nptel.ac.in/courses/112/107/112107084/>
4. <https://nptel.ac.in/courses/112/107/112107144/>
5. <https://nptel.ac.in/courses/112/107/112107078/>
6. <https://nptel.ac.in/courses/112/107/112107239/>
7. <https://nptel.ac.in/courses/112/104/112104195/>
8. <https://nptel.ac.in/courses/112/107/112107219/>
9. <https://nptel.ac.in/courses/112/107/112107144/>
10. <https://nptel.ac.in/courses/112/107/112107213/>
11. <https://nptel.ac.in/courses/112/107/112107090/>
12. <https://nptel.ac.in/courses/113/106/113106087/>
13. <https://nptel.ac.in/courses/112/103/112103263/>
14. <https://nptel.ac.in/courses/112/107/112107239/>
15. <https://nptel.ac.in/courses/112/106/112106153/>
16. <https://nptel.ac.in/courses/112/107/112107250/>
17. <https://nptel.ac.in/courses/112/107/112107144/>
18. <https://nptel.ac.in/courses/112/107/112107239/>
19. <https://nptel.ac.in/courses/112/107/112107219/>

Course Code	Course Name	Credits
MEC304	Materials and Metallurgy	03

Objectives:

1. To familiarize the structure -property correlation in materials
2. To acquaint with the processing dependency on the performance of the various materials
3. To study the role of alloying in the development of steels.
4. To familiarize with the advances in materials development

Outcomes: Learner will be able to

1. Identify the various classes of materials and comprehend their properties
2. Apply phase diagram concepts to engineering applications
3. Apply particular heat treatment for required property development
4. Identify the probable mode of failure in materials and suggest measures to prevent them
5. Choose or develop new materials for better performance
6. Decide an appropriate method to evaluate different components in service

Module	Contents	Hrs.
1	1.1 Classification of materials: Introduction to engineering materials – significance of structure property correlations in all classes of engineering materials 1.2 Concepts of crystals- Crystalline and Non-crystalline Materials Unit cell, Crystal structures of metals, Crystal systems, Crystallographic planes and directions, 1.3 Crystal Defects: Crystal Imperfections-definition, classification and significance of imperfections -point defects, line defects, Surface defects and volume defects. Importance of dislocations in deformation and its mechanisms. Critical Resolved shear stress, Slip systems and deformability of FCC, BCC and HCP lattice systems. 1.4 Cold Working and Recrystallization annealing: Definition, effects and mechanism of cold work, Need for Recrystallization Annealing, the stages of recrystallization annealing and factors affecting it	08
2	2.1 Mechanism of Crystallization- Nucleation-Homogeneous and Heterogeneous Nucleation and Growth. Solidification of metals and - alloys– Cooling curves 2.2 Classification of Alloys based on phases and phase diagram- Binary alloy phase diagram – Isomorphous, Eutectics type I and II, Peritectic 2.3 Iron-Iron carbide phase diagram – Invariant reactions – microstructural changes of hypo and hyper-eutectoid steel- TTT and CCT diagram-Hardenability and its tests, Graphitization in cast irons.	08

3	3.1 Heat treatment: Overview – Objectives – Thorough treatments: Annealing and types, normalizing, hardening and tempering, austempering and martempering – microstructure changes 3.2 Surface hardening processes: Carburizing –, nitriding – cyaniding and carbonitriding, induction and flame hardening, Laser and Electron beam hardening– principles and case depths 3.3 Alloy steels-Stainless steels, Tool steels, Maraging steels and Ausformed steels	06
4	4.1 Strengthening mechanisms in materials 4.2 Fracture of metals – Ductile Fracture, Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT), Griffith's criteria and Orowan's modification 4.3 Fatigue – Endurance limit of ferrous and non-ferrous metals -Fatigue test, S-N curves, factors affecting fatigue, structural changes accompanying fatigue; 4.4 Creep – mechanism of creep – stages of creep and creep test, creep resistant materials	06
5	5.1 Composites: Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites and their applications 5.2 Nano Materials: Introduction, Concepts, synthesis of nanomaterials, examples, applications and Nano composites 5.3 Introduction to Smart materials: Classification, Shape Memory Alloys and its applications	06
6	6.1 Engineering Polymers and Ceramics-types and their advantages over metallic materials 6.2 Processing- of ceramics and composites through Injection Moulding 6.3 Non destructive Testing of Materials-ultrasonic testing, radiographic methods, magnetic particle testing	05

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Textbooks:

1. Callister's Materials Science and Engineering, 2nd edition by R.Balasubramaniam
Wiley India Pvt. Ltd

References:

1. Introduction to Materials Science for Engineers; 8th Edition by James F. Shackelford
Pearson
2. Introduction to Physical Metallurgy, 2nd edition by Sidney Avner, TataMcGrawHill
3. Mechanical Metallurgy, 3rd edition by GH Dieter, TataMcGraw Hill
4. Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition by
William D. Callister, Jr., David G. Rethwisch, Wiley & Sons.
5. Materials Science and Engineering, 5th edition by V.Raghavan, Prentice Hall India

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09/>
2. <https://nptel.ac.in/courses/113/102/113102080/>
3. <https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09/>
4. https://nptel.ac.in/content/syllabus_pdf/113104074.pdf
5. https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_09_m.pdf
6. https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_08_m.pdf
7. <https://nptel.ac.in/courses/112/104/112104229/>
8. <https://nptel.ac.in/courses/118/104/118104008/>
9. https://nptel.ac.in/content/storage2/courses/112104173/Mod_1_smart_mat_lec_6.pdf<https://nptel.ac.in/courses/112/104/112104229/>
10. <https://nptel.ac.in/courses/118/104/118104008/>
11. https://nptel.ac.in/content/storage2/courses/112104173/Mod_1_smart_mat_lec_6.pdf

Course Code	Course Name	Credits
MEC305	Thermodynamics	03

Objectives:

1. To familiarize the concepts of Energy in general and Heat and Work in particular
2. To study the fundamentals of quantification and grade of energy
3. To study the effect of energy transfer on properties of substances in the form of charts and diagrams
4. To familiarize the application of the concepts of thermodynamics in vapour power, gas power cycles, compressible fluid flow

Outcomes: Learners will be able to....

1. Demonstrate application of the laws of thermodynamics to a wide range of systems.
2. Compute heat and work interactions in thermodynamics systems
3. Demonstrate the interrelations between thermodynamic functions to solve practical problems.
4. Compute thermodynamic interactions using the steam table and Mollier chart
5. Compute efficiencies of heat engines, power cycles.
6. Apply the fundamentals of compressible fluid flow to the relevant systems

Module	Detailed contents	Hrs.
1	Basic Concepts : Thermodynamics system and types, Macroscopic and Microscopic approach, Thermodynamic properties of the system, state, path, process and cycle, Point and Path functions, Quasi-static process & Equilibrium, Zeroth law of thermodynamics, Characteristic gas equation, Concept of Internal energy, Enthalpy, Heat and Work. Concept of PdV work. First Law of Thermodynamics: Statement & Equation, First law for Cyclic process (Joule's experiment), Perpetual Motion Machine of the First Kind, Application of first law to non-flow systems (Ideal gas processes with numerical) First law applied to flow system: Concept of flow process and flow energy, Concept of the steady flow process, Energy balance in a steady flow, Application of steady flow energy equation to nozzle, turbine, compressor, pump, boiler, condenser, heat exchanger, throttling device. Steady flow work, Significance of $-VdP$ work, Relation between flow and non-flow work	07
2	Second Law of Thermodynamics: Limitation of the first law of thermodynamics, Thermal reservoir, Concept of heat engine, Heat pump and Refrigerator, Statement of the second law of thermodynamics, Reversible and irreversible Process, Causes of irreversibility, Perpetual Motion Machine of the second kind, Carnot cycle, Carnot theorem. Entropy: Clausius theorem, Entropy is property of a system, Temperature-Entropy diagram, Clausius inequality, Increase of entropy principle, $T ds$ relations, Entropy change During a process.	08

3	Availability: High grade and low-grade energy, Available and Unavailable energy, Dead State, Useful work, Irreversibility, Availability of closed system & steady flow process, Helmholtz & Gibbs function Thermodynamic Relations: Maxwell relations, Clausius-Clapeyron Equation, Mayer relation, Joule-Thomson coefficient (Only Theory)	05
4	Properties of Pure Substance: Advantages and applications of steam, Phase change process of water, Saturation pressure and temperature, Terminology associated with steam, Different types of steam. Property diagram: T-v diagram, p-v diagram, p-T diagram, Critical and triple point, T-s and an h-s diagram for water, Calculation of various properties of wet, dry and superheated steam using the steam table and Mollier chart. Vapour Power cycle: Principal components of a simple steam power plant, Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean temperature of heat addition, Reheat Rankine Cycle.	07
5	Gas Power cycles: Nomenclature of a reciprocating engine, Mean effective pressure, Assumptions of air standard cycle, Otto cycle, Diesel cycle and Dual cycle, Comparison of Otto and Diesel cycle for same compression ratio, Brayton cycle. Sterling Cycle, Ericsson Cycle, Lenoir cycle, and Atkinson cycle (Only theory).	06
6	Compressible Fluid flow: Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Stagnation properties, Application of continuity, momentum and energy equations for steady-state conditions; Steady flow through the nozzle, Isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio.	06

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

References:

1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles, 9th edition, TMH
2. Basic Engineering Thermodynamics by Rayner Joel, 5th edition, Longman Publishers
3. Engineering Thermodynamics by P Chattopadhyay, 2nd edition, Oxford University Press India
4. Thermodynamics by P K Nag, 6th Edition, TMH
5. Thermodynamics by Onkar Singh, 4th Edition New Age International
6. Thermodynamics by C P Arora, 1st Edition TMH
7. Thermal Engineering By Ajoy Kumar, G. N. Sah, 2nd Edition, Narosa Publishing house
8. Engineering Thermodynamics Through Examples by Y V C Rao, Universities Press (India) Pvt Ltd
9. Fundamentals of Thermodynamics by Moran & Shapiro, Eighth Edition, Wiley
10. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., 9th Edition John Wiley & Sons
11. Thermodynamics by W.C. Reynolds, McGraw-Hill & Co
12. Thermodynamics by J P Holman, 4th Edition McGraw-Hill & Co

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/112/105/112105266/>
2. <https://nptel.ac.in/courses/112/103/112103275/>
3. <https://nptel.ac.in/courses/112/105/112105220/>
4. <https://nptel.ac.in/courses/101/104/101104063/>

Course Code	Course Name	Credits
MEL301	Materials Testing	01

Objectives:

1. To familiarize with the use of metallurgical microscope for study of metals
2. To study the microstructures of ferrous (steel and cast iron) metals
3. To acquaint with the material testing by performing experiment related to Hardness , Fatigue, Tension, Torsion, Impact and Flexural Test

Outcomes: Learner will be able to...

1. Prepare metallic samples for studying its microstructure following the appropriate procedure.
2. Identify effects of heat treatment on microstructure of medium carbon steel and hardenability of steel using Jominy end Quench test
3. Perform Fatigue Test and draw S-N curve
4. Perform Tension test to Analyze the stress - strain behaviour of materials
5. Measure torsional strength, hardness and impact resistance of the material
6. Perform flexural test with central and three point loading conditions

a)List of Experiments: Total eight experiments are required to be performed. Four Experiments from each group

Experiment Number	Detailed Contents		Laboratory Sessions (Hrs.)
	Group A		
1.	Study of Characterization techniques and Metallographic sample preparation and etching		02
2.	Comparison of Microstructures and hardness before and after Annealing, Normalizing and Hardening in medium carbon steel	Any two	02
3.	Study of tempering characteristics of hardened steel		
4.	Determination of hardenability of steel using Jominy end Quench Test (Using different hardness testers to measure the Hardness)		
5.	Fatigue test – to determine number of cycles to failure of a given material at a given stress		02
	Group B		
6.	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)		02
7.	Torsion test on mild steel bar / cast iron bar		02
8.	Impact test on metal specimen (Izod/Charpy Impact test)		02
9.	Hardness test on metals – (Brinell/ Rockwell Hardness Number)		02
10.	Flexural test on beam (central loading)		02

b) Assignments: At least one problem on each of the following topics:

1. Simple stress strain
2. SFD and BMD
3. Stresses in beams
4. Torsion and deflection.
5. Thin cylinder and strain energy
6. Buckling of Columns

Note: Preferably, the assignments shall be based on live problems. **Project Based Learning may be incorporated by judiciously reducing number of assignments.**

Assessment:

Term Work: Including Part a and b both

Distribution of marks for Term Work shall be as follows:

Part a: 10 marks.

Part b: 10 Marks

Attendance: 05 marks.

End Semester Practical/Oral Examination:

Pair of Internal and External Examiner should conduct practical examination followed by Oral

Course Code	Course Name	Credits
MEL302	Machine Shop Practice	02

Objectives:

1. To familiarize with basic machining processes.
2. To familiarize various machining operations and machine protocols

Outcomes: Learner will be able to...

1. Know the specifications, controls and safety measures related to machines and machining operations.
2. Use the machines for making various engineering jobs.
3. Perform various machining operations
4. Perform Tool Grinding
5. Perform welding operations

Module	Details	Hrs
1	One composite job consisting minimum four parts employing operations performed of various machine tools.	40
2	Tool Grinding – To know basic tool Nomenclature	04
3	One Job on Welding – Application of Metal Arc Welding	04

Assessment:

Term Work:

1. **Composite job** mentioned above and the **Welding Job**
2. Complete Work-Shop Book giving details of drawing of the job and timesheet

The distribution of marks for Term work shall be as follows:

1. Job Work with complete workshop book 40 marks
2. Attendance 10marks

Course Code	Course Name	Credits
MESBL301	Skill Based Lab: CAD – Modeling	02

Prerequisites: Engineering Drawing

Objectives:

1. To impart the 3D modeling skills for development of 3D models of basic engineering components.
2. To introduce Product data exchange among CAD systems.
3. To familiarize with production drawings with important features like GD &T, surface finish, heat treatments etc.

Outcomes: Learner will be able to...

1. Illustrate basic understanding of types of CAD model creation.
2. Visualize and prepare 2D modeling of a given object using modeling software.
3. Build solid model of a given object using 3D modeling software.
4. Visualize and develop the surface model of a given object using modeling software.
5. Generate assembly models of given objects using assembly tools of a modeling software
6. Perform product data exchange among CAD systems.

Sr. No.	Exercises	Hrs.
1	CAD Introduction CAD models Creation, Types and uses of models from different perspectives. Parametric modeling.	02
2	2D Modeling Geometric modeling of an Engineering component, demonstrating skills in sketching commands of creation (line, arc, circle etc.) modification (Trim, move, rotate etc.) and viewing using (Pan, Zoom, Rotate etc.)	08
3	Solid Modeling 3D Geometric modeling of an Engineering component, demonstrating modeling skills using commands like Extrude, Revolve, Sweep, Blend, Loft etc.	14
4	Surface Modeling Extrude, Sweep, Trim etc and Mesh of curves, free form surfaces etc. Feature manipulation using Copy, Edit, Pattern, Suppress, History operations etc.	10
5	Assembly Constraints, Exploded views, interference check. Drafting (Layouts, Standard & Sectional Views, Detailing & Plotting).	10
6	Data Exchange CAD data exchange formats Like IGES, PDES, PARASOLID, DXF and STL along with their comparison and applicability.	04

Assessment:

Term work

Using the above knowledge and skills acquired through six modules students should complete Minimum six assignments/Experiments from the given sets of assignments **(Two from each set)** using standard CAD modeler like PTC Creo/CATIA/ Solid work/UG /any other suitable software.

Set 1: Beginner Level:

3D modeling of basic Engineering components likes Nuts, Bolts, Keys, cotter, Screws, Springs etc.

Set 2: Intermediate Level:

3D modeling of basic Machine components like Clapper block, Single tool post, Lathe and Milling tail stock, Shaper tool head slide, jigs and fixtures Cotter, Knuckle joint, Couplings: simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling, element of engine system and Miscellaneous parts.

Set 3: Advance Level:

1) Generation of any Assembly model (minimum five child parts) along with Production drawing for any of the system by creating 3D modeling with assembly constraints, Interference check, Exploded view, GD&T, Bill of material.

2) Reverse Engineering of a physical model: disassembling of any physical model having not less than five parts, measure the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions

The distribution of marks for Term work shall be as follows:

1. Printouts/Plots : 20 marks
2. Attendance : 05 marks

End Semester Practical/Oral examination:

To be conducted by pair of Internal and External Examiner

1. Practical examination duration is two hours, based on Advance level of the Term work.
Oral examination should also be conducted to check the knowledge of CAD Modeling Tools.
2. The distribution of marks for practical examination shall be as follows:
 - a. Practical Exam 15 marks
 - b. Oral Exam 10 marks
3. Evaluation of practical examination to be done based on the printout of students work
4. Students work along with evaluation report to be preserved till the next examination

References:

1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing by Laxminarayan and M.L.Mathur, Jain brothers Delhi
3. Machine Drawing by Kamat and Rao
4. Machine Drawing by M.B.Shah
5. A text book of Machine Drawing by R.B.Gupta, Satyaprakashan, Tech. Publication
6. Machine Drawing by K.I. Narayana, P. Kannaiah, K.Venkata Reddy
7. Machine Drawing by Sidheshwar and Kanheya
8. Autodesk Inventor 2011 for Engineers and Designers by ShamTickoo and SurinderRaina, Dreamtech Press

Course code	Course Name	Credits
MEPBL301	Mini Project - 1A	02

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to...

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the

students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.

- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
 - Marks awarded by guide/supervisor based on log book : 10
 - Marks awarded by review committee : 10
 - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
 - First shall be for finalisation of problem
 - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
 - First review is based on readiness of building working prototype to be conducted.
 - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
 - Identification of need/problem
 - Proposed final solution
 - Procurement of components/systems
 - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
 - First shall be for finalisation of problem and proposed solution
 - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
 2. Clarity of Problem definition based on need.
 3. Innovativeness in solutions
 4. Feasibility of proposed problem solutions and selection of best solution
 5. Cost effectiveness
 6. Societal impact
 7. Innovativeness
 8. Cost effectiveness and Societal impact
 9. Full functioning of working model as per stated requirements
 10. Effective use of skill sets
 11. Effective use of standard engineering norms
 12. Contribution of an individual's as member or leader
 13. Clarity in written and oral communication
- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
 - In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Course Code	Course Name	Credits
MEC401	Engineering Mathematics-IV	04

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III, Binomial Distribution, Physical Interpretation of Vector differentiation, Vector differentiation operator, Gradient of scalar point function, Directional derivative, Divergence of vector point function, Curl of vector point function.

Objectives:

1. To study the concept of Vector calculus & its applications in engineering.
2. To study Line and Contour integrals and expansion of complex valued function in a power series.
3. To familiarize with the concepts of statistics for data analysis.
4. To acquaint with the concepts of probability, random variables with their distributions and expectations.
5. To familiarize with the concepts of probability distributions and sampling theory with its applications.

Outcomes: On successful completion of course learner/student will be able to:

1. Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's theorem & Gauss Divergence theorem.
2. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3. Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.
4. Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
5. Apply the concept of probability distribution to engineering problems & testing hypothesis of small samples using sampling theory.
6. Apply the concepts of parametric and nonparametric tests for analyzing practical problems.

Module	Detailed Contents	Hrs.
01	Module : Vector Calculus 1.1 Solenoidal and irrotational (conservative) vector fields. 1.2 Line integrals – definition and problems. 1.3 Green's theorem (without proof) in a plane, Stokes' theorem (without Proof), Gauss' Divergence theorem (without proof) and problems (only evaluation). Self Learning Topics: Identities connecting Gradient, Divergence and Curl, Angle between surfaces. Verifications of Green's theorem, Stoke's theorem & Gauss-Divergence theorem, related identities & deductions.	07
02	Module: Complex Integration 2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 2.2 Taylor's and Laurent's series (without proof). 2.3 Definition of Singularity, Zeroes, poles of $f(z)$, Residues, Cauchy's Residue Theorem (without proof) Self-learning Topics: Application of Residue Theorem to evaluate real integrations.	07

03	Module: Statistical Techniques 3.1 Karl Pearson's Coefficient of correlation (r) and related concepts with problems 3.2 Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems) 3.3 Lines of regression 3.4 Fitting of first and second degree curves. Self-learning Topics: Covariance, fitting of exponential curve.	06
04	Module: Probability Theory: 4.1 Conditional probability, Total Probability and Baye's Theorem. 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, 4.3 Expectation, Variance, Co-variance, moments, Moment generating functions, (Four moments about the origin & about the mean). Self-learning Topics: Properties variance and covariance,	06
05	Module: Probability Distribution and Sampling Theory-I 5.1 Probability Distribution: Poisson and Normal distribution 5.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 5.3 Students' t-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t-test) Self-learning Topics: Test of significance of large samples, Proportion test, Survey based project.	07
06	Module: Sampling theory-II 6.1 Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate's Correction. 6.2 Analysis of variance: F-test (significant difference between variances of two samples) Self-learning Topics: ANOVA: One way classification, Two-way classification (short-cut method).	06

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Vector Analysis, Murray R. Spiegel, Schaum Series
5. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education
6. Probability, Statistics and Random Processes, T. Veerarajan, Mc. Graw Hill education.

Links for online NPTEL/SWAYAM courses:

1. <https://www.youtube.com/watch?v=2CP3m3EgL1Q&list=PLbMVogVj5nJQrzbAweTVvnH6-vG5A4aN5&index=7>
2. <https://www.youtube.com/watch?v=Hw8KHNgRaOE&list=PLbMVogVj5nJQrzbAweTVvnH6-vG5A4aN5&index=8>
3. <https://nptel.ac.in/courses/111/105/111105041/>

Course Code	Course Name	Credits
MEC402	Fluid Mechanics	03

Objectives:

1. To study Fluid Statics and Fluid Dynamics.
2. To acquaint with dimensional analysis of Thermal and Fluid systems.
3. To familiarize with application of mass, momentum and energy equations in fluid flow.
4. To study various flow measurement techniques.
5. To familiarize with the dynamics of fluid flows and the governing nondimensional parameters.

Outcomes: Learner will be able to...

1. **Define** properties of fluids, **classify** fluids and **evaluate** hydrostatic forces on various surfaces.
2. **Illustrate** understanding of dimensional analysis of Thermal and Fluid systems.
3. **Differentiate** velocity potential function and stream function and solve for velocity and acceleration of a fluid at a given location in a fluid flow.
4. **Formulate** and **solve** equations of the control volume for fluid flow systems and Apply Bernoulli's equation to various flow measuring devices.
5. **Calculate** pressure drop in laminar and turbulent flow, evaluate major and minor losses in pipes.
6. **Calculate** resistance to flow of incompressible fluids through closed conduits and over surfaces.

Module	Detailed Contents	Hrs.
1.	1.1 Basic Concepts: Significance of fluid mechanics, physical properties of fluid, Newton's law of viscosity, Newtonian and non-Newtonian Fluid. 1.2 Fluid Statics: Pascal's law, hydrostatic law, hydrostatic force on submerged surfaces (vertical, inclined & curved). Archimedes principle, buoyancy.	06
2.	2.1 Fluid Kinematics: Classification of fluid flow, streamline, path line, streak line, acceleration of fluid particle, differential equation of continuity, rotational flow and vortices, stream function, potential function, concept of circulation. 2.2 Dimensional Analysis: Introduction to dimensional analysis of thermal and fluid systems, Methods of dimensional analysis - Buckingham π Theorem and Rayleigh's Method (Only derivations, no numerical)	07
3.	3.1 Fluid Dynamics: Concept of control volume and control surface, Importance of Reynolds Transport theorem (RTT) and its derivation (No numerical). Forces acting on fluid in motion, Euler's equation in Cartesian coordinates, Expression of Bernoulli's equation from principle of energy conservation and by integration of Euler's equation. Application of Bernoulli's equation in Orifice meter, Venturi meter, Rotameter and Pitot tube. Momentum of fluid in motion: impulse momentum relationship and its applications for determination of thrust for pipe bend.	09

4.	4.1 Laminar Viscous flow: Introduction to Reynolds number, critical Reynolds number, Navier-Stokes equation of motion, Relationship between shear stress and pressure gradient in laminar flow, Laminar flow between parallel plates (Plane Poiseuille & Couette flow), Laminar flow in circular pipe (Hagen-Poiseuille flow).	06
5.	5.1 Flow through pipes : Reynolds experiment, Head loss in pipes due to friction (Darcy-Weisbach equation), Loss of energy in pipe (major and minor), Hydraulic gradient and Energy gradient line, Pipes in series and parallel, concept of equivalent pipe.	06
6.	6.1 Hydrodynamic Boundary Layer Theory: Concept of formation of boundary layer, boundary layer parameters, boundary layer along a long thin plate and in pipe, Prandtl boundary layer equation, Separation of boundary layer and its methods of control. 6.2 Flow around submerged objects: Concept of drag and lift, Types of drag, Streamlined and bluff bodies, Drag and lift on an aerofoil.	05

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

References:

1. Fluid Mechanics by Yunus A Cengel and John M Cimbala, Tata McGraw Hill Education, 3rd Edition, 2014.
2. Fluid Mechanics and Machinery by C S P Ojha, Chandramouli and R Berndtsson, Oxford University Press, 1st Edition, 2010.
3. Fox and McDonald's Introduction to Fluid Mechanics by Philip J. Pritchard and John W. Mitchell, Wiley Publishers, 9th Edition, 2016.
4. A textbook of Fluid Mechanics by R K Bansal, Laxmi Publication, 1st Edition, 2015.
5. Fluid Mechanics by Frank M. White, McGraw Hill Education, 7th Edition, 2011.
6. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 9th Edition, 2010.
7. Engineering Fluid Mechanics by K. L. Kumar, Eurasia Publishing House (P) Ltd, 1st Edition and Reprint 2016.
8. Introduction to Fluid Mechanics by James A. Fay, MIT Press, Cambridge, 1st Edition, 1996.
9. Fluid Mechanics and Hydraulics by Suresh Ukaranade, Ane Books Pvt.Ltd, Revised & Updated 1st Edition, 2016.

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/112/105/112105269>
2. https://swayam.gov.in/nd1_noc20_ce59/preview

Course Code	Course Name	Credits
MEC403	Kinematics of Machinery	03

Objectives:

1. To acquaint with basic concept of kinematics and kinetics of machine elements
2. To familiarize with basic and special mechanisms
3. To study functioning of motion and power transmission machine elements

Outcomes: Learner will be able to...

1. Identify various components of mechanisms
2. Develop mechanisms to provide specific motion
3. Draw velocity and acceleration diagrams of various mechanisms
4. Choose a cam profile for the specific follower motion
5. Predict condition for maximum power transmission in the case of a belt drive
6. Illustrate requirements for an interference-free gear pair

Module	Content	Hrs.
1	1.1 Kinetics of Rigid Bodies Concept of mass moment of inertia and its application to standard objects. Kinetics of rigid bodies: Work and energy Kinetic energy in translating motion, Rotation about fixed axis and in general plane motion, Work energy principle and Conservation of energy 1.2 Basic Kinematics Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Gr��bler's criterion & its limitations Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions	07
2	Special Mechanisms (No problems on this module) 2.1 Straight line generating mechanisms: Introduction to Exact straight line generating mechanisms - Peaucillier's and Hart's Mechanisms, Introduction to Approximate Straight line generating mechanisms- Watt's, Grasshopper mechanism, Tchebicheff's mechanisms 2.2 Offset slider crank mechanisms - Pantograph, Hook-joint (single and double). 2.3 Steering Gear Mechanism - Ackerman, Davis steering gears	04
3	3.1 Velocity Analysis of Mechanisms (mechanisms up to 6 links) Velocity analysis by instantaneous centre of rotation method (Graphical approach), Velocity analysis by relative velocity method (Graphical approach) 3.2 Acceleration Analysis of Mechanisms (mechanisms up to 6 links) Acceleration analysis by relative method including pairs involving Coriolis acceleration (Graphical approach)	10
4	Cam and Follower Mechanism 4.1 Cam and its Classification based on shape, follower movement, and manner of constraint of follower; Followers and its Classification based on shape, movement, and location of line of movement; Cam and follower terminology; 4.2 Motions of the follower: SHM, Constant acceleration and deceleration (parabolic), Constant velocity, Cycloidal; Introduction to cam profiles (No problems on this point)	04

5	Belts, Chains and Brakes: 5.1 Belts: Introduction, Types and all other fundamentals of belting, Dynamic analysis –belt tensions, condition of maximum power transmission 5.2 Chains (No problems): types of chains, chordal action, variation in velocity ratio, length of chain (No problems) 5.3 Brakes (No problems): Introduction, types and working principles, Introduction to braking of vehicles	04
6	Gears and Gear Trains: 6.1 Gears- Introduction, Types, Law of gearing, Forms of teeth, Details of gear terminology, Path of contact, Arc of contact, Contact ratio, Interference in involutes gears, Minimum number of teeth for interference free motion, Methods to control interference in involutes gears, Static force analysis in gears - spur, helical, bevel, worm & worm wheel (No problems on this point) 6.2 Gear Trains: Kinematics and dynamic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur or bevel gear combination	10

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text Books:

1. S.S. Ratan, “Theory of Machines”, Tata McGraw Hill
2. Ghosh and A.K. Mallik, “Theory of Mechanisms and Machines”, East-West Press

References:

1. J.J. Uicker, G.R. Pennock, and J.E. Shigley, “Theory of Machines and Mechanism”, Oxford Higher Education
2. P.L. Ballaney, “Theory of Machines”, Khanna Publishers
3. M.A. Mostafa, “Mechanics of Machinery”, CRC Press
4. R.L. Norton, “Kinematics and Dynamics of Machinery”, McGraw Hill
5. A.G. Erdman, G.N. Sander, and S. Kota, “Mechanism Design: Analysis and Synthesis Vol I”, Pearson

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/112/105/112105268/>
2. <https://www.youtube.com/playlist?list=PLYRGB44zNZWVibVLmWANp-7obQzOhJLRt>
3. <http://www.nptelvideos.in/2012/12/kinematics-of-machines.html>

Course Code	Course Name	Credits
MEC404	CAD/CAM	03

Objectives:

1. To familiarize with basic concepts of computer graphics.
2. To acquaint with the process of using biomedical data for 3D modeling.
3. To study programming aspects of subtractive manufacturing process.
4. To familiarize with basic process of additive manufacturing in particularly 3D printing.

Outcomes: Learner will be able to...

1. Identify suitable computer graphics techniques for 3D modeling.
2. Transform, manipulate objects & store and manage data.
3. Develop 3D model using various types of available biomedical data.
4. Create the CAM Toolpath for specific given operations.
5. Build and create data for 3D printing of any given object using rapid prototyping and tooling processes.
6. Illustrate understanding of various cost effective alternatives for manufacturing products.

Module	Details	Hrs.
1.	Computer Graphics 1.1 Introduction: Scope of CAD/CAM in product life cycle, CAD/CAM hardware and software, 2D and 3D computer graphics representation, Mapping of Geometric Models. 1.2 Parametric representation of curves and surfaces: Synthetic Curves - Bezier curves, Hermite Curves, B-spline curves. Surface representation. 1.3 Solid Modeling: Constructive solid geometry (CSG), Boundary Representation (B-Rep), Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling, Feature based modeling, Constraint Based Modeling.	07
2.	Geometric Transformation 2.1 Homogeneous Coordinate system, Matrix representation, Concatenations, 2D and 3D geometric transformation (Translation, Reflection, Scaling, Rotation)	07
3.	Modeling based on Biomedical data 3.1 Introduction to medical imaging: Computed tomography (CT), Cone beam CT (CBCT), Magnetic resonance (MR), Noncontact surface scanning, Medical scan data, Point cloud data 3.2 Working with medical scan data: Pixel data operations, Using CT data: a worked example, Point cloud data operations, Two-dimensional formats, Pseudo 3D formats, True 3D formats, File management and exchange	06
4.	Subtractive Manufacturing 4.1 Introduction: NC/CNC/DNC machines, Machining Centers, Coordinate system 4.2 CNC machining practices and programming: setup, and operation of two- and three-axis CNC machines programming using manual part programming method, Canned Cycles.	07

5.	Additive Manufacturing 5.1 Rapid Prototyping: Introduction, Classification of RP Processes, Advantages & disadvantages. RP Applications; in Design, Concept Models, Form & fit checking, Functional testing, CAD data verification, Rapid Tooling, and bio fabrication. 5.2 Working Principle, Application, Advantages & disadvantages: of Stereolithography Apparatus (SLA) Selective Laser Sintering (SLS), 3D Printing, Fused Deposition Modeling (FDM), and Laminated Object Manufacturing (LOM)	07
6.	Virtual Manufacturing 6.1 Virtual Manufacturing: Introduction, Scope, Socio-economic Aspects and Future Trends	05

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

References:

1. CAD/ CAM, Theory & Practice, Ibrahim Zeid, R. Sivasubramanian, Tata McGraw Hill Publications
2. CAD/CAM Principles and Applications, P. N. Rao, Tata McGraw Hill Publications
3. CAD/CAM Computer Aided and Manufacturing, Mikell P. Groover and Emory W. Zimmers, Jr., Eastern Economy Edition
4. CNC Technology and Programming, Krar, S., and Gill, A., McGraw Hill Publishers.
5. Medical Modelling The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd.
6. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, I. Gibson I D. W. Rosen I B. Stucker, Springer Publication.
7. Rapid Prototyping and Manufacturing, P. F. Jacobs, Society of Manufacturing Engineers
8. Advanced Machining and Manufacturing Processes, Kaushik Kumar DivyaZindani, J. Paulo Davim, Springer International Publishing

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/112/102/112102101/>
2. <https://nptel.ac.in/courses/106/102/106102065/>
3. <https://nptel.ac.in/courses/106/102/106102065/>
4. <https://nptel.ac.in/courses/112/102/112102103/>
5. <https://nptel.ac.in/courses/112/105/112105211/>
6. <https://nptel.ac.in/courses/112/104/112104265/>
7. <https://www.youtube.com/watch?v=2cCMty9v3Tg>
8. <https://www.youtube.com/watch?v=2zPh26Q1BT8>

Course Code	Course Name	Credits
MEC404	Industrial Electronics	03

Objectives:

1. To study power electronic switches and circuits and their applications.
2. To acquaint with basics of analog and digital circuits for the design of mechanical processes control.
3. To study structure, working and characteristics of different types of industrial electric motors and their selection for a particular application.

Outcomes: Learner will be able to...

1. Illustrate construction, working principles and applications of power electronic switches.
2. Identify rectifiers and inverters for dc and ac motor speed control.
3. Develop circuits using OPAMP and Timer IC 555.
4. Identify digital circuits for industrial applications.
5. Demonstrate the knowledge of basic functioning of microcontrollers.
6. Analyze speed-torque characteristics of electrical machines for speed control.

Module	Detailed Contents	Hrs.
1.	Semiconductor Devices: Review of diodes, V-I characteristics and Applications of: rectifier diode, zener diode, LED, photodiode; SCR V-I characteristics, UJT triggering circuit, turning-off of a SCR (preliminary discussion), basics of Gate Turn Off (GTO), Structure and V-I characteristics of Triac (modes of operation not needed) and Diac, Applications of Triac-Diac circuit; Characteristics of Power BJT, power MOSFET, IGBT; Comparison of SCR, Triac, Power BJT, power MOSFET, IGBT	08
2.	Phase controlled rectifiers and Bridge inverters: Full wave controlled rectifier using SCR's(semi controlled, fully controlled) with R load only, Block diagram of closed loop speed control of DC motors, Basic principle of single phase and three phase bridge inverters , block diagrams including rectifier and inverter for speed control of AC motors (frequency control only)	07
3.	Operational amplifiers and 555 Timer: Operational amplifier circuits, Ideal OPAMP behaviour, common OPAMP ICs; Basic OPAMP circuits- Inverting amplifier, Non-inverting amplifier, Voltage follower (Buffer), Comparator, Instrumentation Amplifier, Active first order filter: Low pass and high pass filter; Power Op Amps, IC-555 timer-Operating modes: monostable, astablemultivibrator	05
4.	Digital logic and logic families: Boolean algebra and logic gates. logic families: Logic Levels, Noise Immunity, Fan Out, Propagation Delay, TTL and CMOS logic families, Flip flops: Set Reset(SR), Trigger(T), clocked F/Fs; Registers, Multiplexer and Demultiplexer applications	05

5.	Microprocessor and Microcontrollers: Overview of generic microprocessor, architecture and functional block diagram, Comparison of microprocessor and microcontroller MSP430 architecture, assembly language programming, C compiler programming, basics of interfacing with external input / output devices (like reading external analog voltages, digital input output) Applications of microcontroller: Temperature measurement, Speed Measurement using Proximity Sensor, Piezoelectric Actuator Drive	08
6.	Motors: Review and comparison of DC motors and AC induction motors, Basic principles of speed control of AC induction motor, Basics of BLDC motor, Linear Actuator motor, Servo Motor; Motor Specifications, suitability of each motor for various industrial applications, Selection and sizing of motors for different applications. Applications for pumps, conveyors, machine tools, Microcontroller based speed control for Induction Motor.	06

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

References:

1. Power Electronics M.H. Rashid, Prentice-Hall of India
2. Power Electronics, P S Bhimbra
3. Power Electronics, VedamSubramanyam, New Age International
4. Power Electronics, Ned Mohan, Undeland, Robbins, John Wiley Publication
5. Electronic Devices and Circuits, Robert Boylestad and Louis Nashelsky, Prentice-Hall
6. Industrial Electronics and Control by S K Bhattacharya, S Chatterjee, TTTI Chandigarh
7. Modern Digital Electronic, Jain R P, Tata McGraw Hill, 1984
8. Digital principal and Application, Malvino and Leach, Tata McGraw Hill, 1991
9. Fundamentals of Microcontrollers and Embedded System, Ramesh Gaonkar, PENRAM
10. MSP430 Microcontroller Basics, John H. Davies, Newnes; 1 edition 2008

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/108/108/108108122/>
2. <https://nptel.ac.in/courses/108/105/108105066/>
3. <https://nptel.ac.in/courses/108/101/108101091/>
4. <https://nptel.ac.in/courses/106/108/106108099/>
5. <https://nptel.ac.in/courses/108/105/108105102/>
6. <https://nptel.ac.in/courses/108/102/108102146/>

Course Code	Course Name	Credits
MEL401	Industrial Electronics	01

Objectives:

1. To study operational characteristics of various analog and digital circuits.
2. To study microcontroller-based applications and its programming
3. To study operational characteristics of electrical motors.

Outcomes: Learner will be able to...

1. Demonstrate characteristics of various electrical and electronics components
2. Develop simple applications built around these components
3. Identify use of different logic gates and their industrial applications
4. Built and demonstrate parameter measurements using microcontroller
5. Test and Analyze speed-torque characteristics of electrical machines for speed control.

List of Experiments: Minimum ten experiments need to be performed, six from 1-9 and four from 10-15.

Sr.No.	List of Experiments
1.	MOSFET / IGBT as a switch
2.	V-I characteristics of SCR
3	Triggering circuit of SCR (UJT)
4.	Light dimmer circuit using Diac-Triac
5.	Full wave Rectifier using SCR with R /R-L load
6.	Single phase Bridge inverter with rectifier load
7.	OPAMP as Inverting and Non inverting amplifier.
8.	OPAMP as a Comparator
9.	555 timer as AstableMultivibrator
10.	Study of logic gates and Logic Operations like, NOT, AND, OR
11.	Realization of basic gates using universal gates
12.	Speed control of DC motor
13.	Speed control of induction motor
14.	Simple programs using microcontroller
15.	Simple microcontroller based application like Temp Measurement/ Speed Measurement using Proximity Sensor/ Piezoelectric Actuator Drive
16.	Microcontroller based speed control for Induction Motor

Assessment:

Distribution of marks for term work

Laboratory work

20 Marks

Attendance

05 Marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:
 - a. Practical performance 15 marks
 - b. Viva 10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL402	Kinematics of Machinery	01

Objectives:

1. To familiarize with various mechanisms and inversions
2. To acquaint with basics of power transmission systems

Outcomes: Learner will be able to...

1. Draw velocity diagram using Instantaneous Centre method
2. Find velocity and acceleration of a point on a four-bar mechanism by using Relative method.
3. Analyze velocity and acceleration of a specific link of a slider crank mechanism using graphical approach by Relative method.
4. Plot displacement-time, velocity-time, and acceleration-time diagrams of follower motion.
5. Draw cam profile for the specific follower motion.
6. Develop and build mechanisms to provide specific motion.

Term Work: Comprises of (a) and (b)

(a) Laboratory Work

Sr. No.	Details	Hrs.
1.	Analysis of velocity of mechanisms by Instantaneous Centre of Rotation method – 3 to 5 problems	04
2.	Analysis of velocity of mechanisms by Relative Velocity method – 3 to 5 problems	04
3.	Analysis of acceleration of mechanism by Relative method including pairs involving Coriolis acceleration – 3 to 5 problems	04
4.	Motion analysis and plotting of displacement-time, velocity-time and acceleration-time, jerk-time, and layout of cam profiles - 2 to 3 problems	06
5.	Mini project on design and fabrication of any one mechanism for a group of maximum 4 students	08

(b) Assignments: Minimum two problems on each of the following topics

Sr. No.	Topic
1.	Belts and Chains
2.	Brakes
3.	Gears and Gear trains

Assessment:

Distribution of marks for Term Work shall be as follows:

1. Laboratory Work : 15marks.
2. Assignments : 05 Marks
3. Attendance : 05 marks

Course Code	Course Name	Credits
MEL403	Python Programming	01

Objectives:

1. To introduce basic concepts of Python programming language as well as common packages and libraries.
2. To generate an ability to design, analyze and perform experiments on real life problems in mechanical engineering using python.

Outcomes: Learner will be able to....

1. Demonstrate understand of basic concepts of python programming.
2. Identify, install and utilize python packages
3. Develop and execute python programs for specific applications.
4. Develop and build python program to solve real-world engineering problems
5. Prepare a report on case studies selected.

Module	Details	Hrs.
1.	Introduction to python and its applications. Installation of Python and setting up a programming environment such as Anaconda and Spyder Python Basics: Variable and variable types, Booleans, Numbers (integers, floats, fractions, complex numbers), strings, lists, tuples, sets, dictionaries. bytes and byte arrays, Manipulating variables, indexing, slicing, basic operators (arithmetic, relational, logical, membership, identity). String methods, list methods, list slicing, set methods, in built python functions, input and output functions.	04
2.	Basic Coding in Python: If, else, elif statements, for loops, range function, while loops, List comprehensions, functions in python. Introduction to OOP, Classes, Objects, Reading and writing files.	02
3.	Python libraries: Installing of different libraries, packages or modules. Basic concepts of the following libraries: NumPy, Matplotlib, Pandas, SciPy Optional libraries based on case studies in Module 4: Pillow, Scikit, OpenCV, Python in Raspberry Pi	04
4.	Case Studies using Python (Select any 3): 1. Solving a linear differential equation using SciKit and plotting the result in matplotlib. Students can use differential equations from any previous topic studied in the programme such as mechanics, materials science, fluid mechanics, kinematics of machines, thermodynamics, production etc. 2. Image processing and manipulation and auto detection of any object. Applications in self-driving cars may be discussed. 3. Python programming of a Raspberry PI: Students can sense using a sensor, process the reading and then control some physical output (like motor or LED) 4. Project involving basic machine learning (Students should understand the basic concepts of machine learning and apply to specific situation) 5. Any other case study that uses Python to solve Mechanical Engineering problems. 6. Customizing applications by writing API programs using python like to create joints, get physical properties, get circle and arc data from edge.	06

Note: In module 4: Advanced learners may opt to do multiple case studies beyond minimum required. Student with laptops or personal computers should be encouraged to install Python on it and independently work on these projects. Students should prepare a short report for each case study and submit their findings. They should also give a presentation on their case study as well as a live demonstration of their projects.

Assessment:

Internal:

Distribution of term work marks as below;

1. Laboratory Work:	5 Marks
2. Case Study Reports and Presentation: 5 marks each:	15 marks
3. Attendance:	5 Marks

External Practical/Oral:

1. Practical examination of 2 hours duration followed by Oral to be conducted by Pair of Internal and External Examiner based on contents
2. Evaluation of practical examination to be done by examiner based on the printout of students work
3. Distribution of marks
 - a. Practical examination: 20 marks
 - b. Oral based on practical examination: 05 marks

Note: Students work along with evaluation report to be preserved till the next examination

References:

1. Core Python Programming, Dr. R. NageswaraRao, Dreamtech Press
2. Programming through Python, M.T.Savaliya and R.K.Maurya, StarEdu Solutions
3. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication2.
4. Any digital resources and online guides for python or its packages. Such as "The Python Tutorial", <http://docs.python.org/release/3.0.1/tutorial/>

Course Code	Course Name	Credits
MESBL401	Skill based Lab: CNC and 3-D Printing	02

Objectives:

1. To familiarize with subtractive manufacturing process in particular CNC systems.
2. To acquaint with basic part programming process for specific operations.
3. To familiarize with additive manufacturing process in particularly 3D printing.
4. To acquaint with basic process of 3D modeling using biomedical data.

Outcomes: Learner will be able to....

1. Develop and execute part programming for any given specific operation.
2. Build any given object using various CNC operations.
3. Demonstrate CAM Tool path and prepare NC- G code.
4. Develop 3D model using available biomedical data
5. Build any given real life object using 3D printing process.
6. Convert 2D images into 3D model

Sr. No.	List of Exercises	Hrs.
1	Part programming and part fabrication on CNC Turning trainer (Involving processes like Step turning, facing, Taper turning, threading, etc.) (One job in a group of 4-5 students)	24
2	Part programming and part fabrication on CNC Milling trainer (Involving processes like contouring, drilling, facing, pocketing etc.) (One job in a group of 4-5 students)	
3	Part Programming Simulation for any Unconventional Machining Process (Electric Discharge Machining, laser cutting Machining, Plasma Cutting Machining etc.)	
4	Tool-path generation by translation of part geometry from computer aided design (CAD) to computer aided manufacturing (CAM) systems.	
5	Post processing of Code generated via CAM system	
6	Case Study: Report on a visit conducted to any Commercial CNC Machining Centre explaining the Design features, pre processing in CAM software and its capabilities.	
7	Development of physical 3D mechanical structure using any one of the rapid prototyping processes.	24
8	Check the constraints of any two RP systems for features like layer thickness, orientation of geometry, support generation, post processing etc.	

9	Design an object with free form surface & printing it using any RP process.	
10	Segmentation in Slicer's Segment Editor module for the purpose of 3D printing (3D Slicer open source) (Application: Any Bone part as per available Dicom files)	
11	Creation of 3D model from 2D images using any image processing software and printing it. (3D Slicer open source) (Application: Any body organ like Heart, Gallbladder etc. as per available Dicom files)	
12	Case Study: Usability of rapid tooling integrated investment casting process, with their advantages and limitations in any one of emerging areas of dentistry, jewelry, surgical implants, turbine blades, etc.	

Assessment:

Term work shall consist of

- Any **4 exercises from 1 to 6 and 3 exercises from 7 to 11 of the above list**
- Exercise 12 is mandatory.

The distribution of marks for term work shall be as follows:

1. Part A Exercises: 10 Marks
2. Part B Exercises: 10 Marks
3. Attendance: 05 Marks

Practical/Oral examination

1. Each student will be given a practical assignment on the basis of the above exercises which will be completed within a given time and assessed by examiners during the oral examination.
2. The distribution of marks for oral-practical examination shall be as follows:
 - a. Practical Assignment : 15 marks
 - b. Oral : 10 marks
3. Evaluation of practical/oral examination to be done based on the performance of practical assignment.
4. Students work along with evaluation report to be preserved till the next examination

References:

1. CAD/CAM Principles and Applications, P. N. Rao, Tata McGraw Hill Publications
2. CNC Technology and Programming, Krar, S., and Gill, A., McGraw Hill Publishers.
3. CNC Programming for Machining, Kaushik Kumar, ChikeshRanjan, J. Paulo Davim, Springer Publication.
4. Medical Modelling The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd.

5. Biomaterials, artificial organs and tissue engineering, Edited by Larry L. Hench and Julian R. Jones, Woodhead Publishing and Maney Publishing, CRC Press 2005
6. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, I. Gibson | D. W. Rosen | B. Stucker, Springer Publication.
7. Rapid Prototyping and Manufacturing, P. F. Jacobs, Society of Manufacturing Engineers

Course code	Course Name	Credits
MEPBL 401	Mini Project - 1B	02

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to...

5. Identify problems based on societal /research needs.
6. Apply Knowledge and skill to solve societal problems in a group.
7. Develop interpersonal skills to work as member of a group or leader.
8. Draw the proper inferences from available results through theoretical/experimental/simulations.
9. Analyse the impact of solutions in societal and environmental context for sustainable development.
10. Use standard norms of engineering practices
11. Excel in written and oral communication.
12. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
13. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
 - Marks awarded by guide/supervisor based on log book : 10
 - Marks awarded by review committee : 10
 - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
 - First shall be for finalisation of problem
 - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
 - First review is based on readiness of building working prototype to be conducted.
 - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
 - Identification of need/problem
 - Proposed final solution
 - Procurement of components/systems
 - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
 - First shall be for finalisation of problem and proposed solution
 - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
 2. Clarity of Problem definition based on need.
 3. Innovativeness in solutions
 4. Feasibility of proposed problem solutions and selection of best solution
 5. Cost effectiveness
 6. Societal impact
 7. Innovativeness
 8. Cost effectiveness and Societal impact
 9. Full functioning of working model as per stated requirements
 10. Effective use of skill sets
 11. Effective use of standard engineering norms
 12. Contribution of an individual's as member or leader
 13. Clarity in written and oral communication
- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
 - In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

University of Mumbai



No. AAMS (UG)/74 of 2021-22

CIRCULAR :-

Attention of the Principals of the Affiliated Colleges, Directors of the recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/44 of 2018-19 dated 25th June, 2018 relating to the revised syllabus as per the (CBCS) for T.E. in Civil Engineering (Sem - V & VI).

They are hereby informed that the recommendations made by the Board of Studies in Civil Engineering at its meeting held on 27th April, 2021 and subsequently made by the Board of Deans at its meeting held on 11th June, 2021 vide item No. 6.2 (R) have been accepted by the Academic Council at its meeting held on 29th June, 2021 vide item No. 6.2 (R) and that in accordance therewith, the revised syllabus (Rev-2019 'C' Scheme) for the B.E. in Civil Engineering (T.E. - Sem. V & VI) has been brought into force with effect from the academic year 2021-22. (The same is available on the University's website www.mu.ac.in).

MUMBAI - 400 032
30th September, 2021
To

(Dr. B.N. Gaikwad)
I/c REGISTRAR

The Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology.

A.C/6.2/29/06/2021

No. UG/74 -A of 2021-22

MUMBAI-400 032

30th September, 2021

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology.
- 2) The Chairman, Board of Studies in Civil Engineering.
- 3) The Director, Board of Examinations and Evaluation.
- 4) The Director, Board of Students Development.
- 5) The Co-ordinator, University Computerization Centre.

(Dr. B.N. Gaikwad)
I/c REGISTRAR

Copy to :-

- 1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
- 2. The Deputy Registrar, College Affiliations & Development Department (CAD),**
- 3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
- 4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
- 5. The Deputy Registrar, Executive Authorities Section (EA),**
- 6. The Deputy Registrar, PRO, Fort, (Publication Section),**
- 7. The Deputy Registrar, (Special Cell),**
- 8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
- 9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

- 1. P.A to Hon'ble Vice-Chancellor,**
- 2. P.A Pro-Vice-Chancellor,**
- 3. P.A to Registrar,**
- 4. All Deans of all Faculties,**
- 5. P.A to Finance & Account Officers, (F.& A.O),**
- 6. P.A to Director, Board of Examinations and Evaluation,**
- 7. P.A to Director, Innovation, Incubation and Linkages,**
- 8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
- 9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
- 10. The Director of Board of Student Development,**
- 11. The Director, Department of Students Welfare (DSD),**
- 12. All Deputy Registrar, Examination House,**
- 13. The Deputy Registrars, Finance & Accounts Section,**
- 14. The Assistant Registrar, Administrative sub-Campus Thane,**
- 15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
- 16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
- 17. The Assistant Registrar, Constituent Colleges Unit,**
- 18. BUCTU,**
- 19. The Receptionist,**
- 20. The Telephone Operator,**
- 21. The Secretary MUASA**

for information.

UNIVERSITY OF MUMBAI



Bachelor of Engineering

in

Civil Engineering

Second Year with Effect from AY 2020-2021

Third Year with Effect from AY 2021-2022

Final Year with Effect from AY 2022-2023

(REV-2019 'C' Scheme) from Academic Year 2019-2020

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic
year 2019-2020)

Syllabus for Approval

Title of the Course	: Third Year in Bachelor of Civil Engineering
Eligibility for Admission	: After Passing First Year Engineering as per the Ordinance 0.6242
Passing Marks	: 40%
Ordinances / Regulations (if any)	: Ordinance 0.6242
No. of Years / Semesters	: 8 semesters
Level	: Under Graduation
Pattern	: Semester
Status	: New
To be implemented from Academic Year	: With effect from Academic Year: 2021-2022

Dr. S. K. Ukarande

Associate Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Dr Anuradha Muzumdar

Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Third Year of Engineering from the Academic year 2021-22. Subsequently this will be carried forward for Final Year Engineering in the academic years 2022-23.

Dr. S. K. Ukarande

Associate Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Dr Anuradha Muzumdar

Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill-based activities and project-based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande

Associate Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Dr Anuradha Muzumdar

Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Preface

The engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program Outcomes (POs) are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome-based education (OBE) in the process of curriculum development from Rev-2012 onwards and continued to enhance the curriculum further based on OBE in Rev-2016 and Rev-2019 “C” scheme.

As Chairman and Members of Board of Studies in Civil Engineering, University of Mumbai, we are happy to state here that, the Program Educational Objectives (PEOs) for Undergraduate Program were finalized in a brain storming session, which was attended by more than 40 members from different affiliated Institutes of the University, who are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The PEOs finalized for the undergraduate program in Civil Engineering are listed below;

1. To prepare the Learner with a sound foundation in mathematical, scientific and engineering fundamentals
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems
3. To prepare the Learner for a successful career in Indian and Multinational Organisations and for excelling in post-graduate studies
4. To motivate learners for life-long learning
5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner’s thought process

In addition to the above listed PEOs, every institute is encouraged to add a few (2-3) more PEOs suiting their institute vision and mission

Apart from the PEOs, for each course of the program, objectives and expected outcomes from a learner’s point of view are also included in the curriculum to support the philosophy of OBE. We strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stakeholders.

Board of Studies in Civil Engineering University of Mumbai			
Dr. S. K. Ukarande	Chairman	Dr. V. Jothiprakash	Member
Dr. D.D. Sarode	Member	Dr. K. K. Sangle	Member
Dr. S. B. Charhate	Member	Dr. D. G. Regulawar	Member
Dr. Milind Waikar	Member	Dr. A. R. Kambekar	Member
Dr. R.B. Magar	Member	Dr. Seema Jagtap	Member

Undergraduate Program Structure for Second year Civil Engineering

University of Mumbai

(With Effect from A. Y. 2020-2021)

Semester – III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC301	Engineering Mathematics – III	03	-	01	03	-	01	04
CEC302	Mechanics of Solids	04	-	-	04	-	-	04
CEC303	Engineering Geology	03	-	-	03	-	-	03
CEC304	Architectural Planning & Design of Buildings	02	-	-	02	-	-	02
CEC305	Fluid Mechanics – I	03	-	-	03	-	-	03
CEL301	Mechanics of Solids	-	02	-	-	01	-	01
CEL302	Engineering Geology	-	02	-	-	01	-	01
CEL303	Architectural Planning & Design of Buildings	-	02	-	-	01	-	01
CEL304	Fluid Mechanics – I	-	02	-	-	01	-	01
CEL305	Skill Based Lab Course – I	-	03	-	-	1.5	-	1.5
CEM301	Mini Project – 1A	-	03 ^{\$}	-	-	1.5	-	1.5
Total		15	14	1	15	7	1	23

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC301	Engineering Mathematics –III	20	20	20	80	03	25	-	125
CEC302	Mechanics of Solids	20	20	20	80	03	-	-	100
CEC303	Engineering Geology	20	20	20	80	03	-	-	100
CEC304	Architectural Planning & Design of Buildings	20	20	20	80	03	-	-	100
CEC305	Fluid Mechanics – I	20	20	20	80	03	-	-	100
CEL301	Mechanics of Solids	-	-	-	-	-	25	25	50
CEL302	Engineering Geology	-	-	-	-	-	25	25	50
CEL303	Architectural Planning & Design of Buildings	-	-	-	-	-	25	25	50
CEL304	Fluid Mechanics – I	-	-	-	-	-	25	25	50
CEL305	Skill Based Lab Course – I	-	-	-	-	-	50	-	50
CEM301	Mini Project – 1A	-	-	-	-	-	50	-	50
Total		100			400	-	225	100	825

\$ indicates work load of Learner (Not Faculty), for Mini Project.

Undergraduate Program Structure for Second year Civil Engineering

University of Mumbai

(With Effect from A.Y. 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC401	Engineering Mathematics – IV	03	-	01	03	-	01	04
CEC402	Structural Analysis	04	-	-	04	-	-	04
CEC403	Surveying	03	-	-	03	-	-	03
CEC404	Building Materials & Concrete Technology	03	-	-	03	-	-	03
CEC405	Fluid Mechanics-II	03	-	-	03	-	-	03
CEL401	Structural Analysis	-	02	-	-	01	-	01
CEL402	Surveying	-	03	-	-	1.5	-	1.5
CEL403	Building Material Concrete Technology	-	02	-	-	01	-	01
CEL404	Fluid Mechanics-II	-	02	-	-	01	-	01
CEL405	Skill Based lab Course – II	-	02	-	-	01	-	01
CEM401	Mini Project – 1B	-	03 ^{\$}	-	-	1.5	-	1.5
Total		16	14	01	16	07	01	24

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test - I	Test – II	Avg.					
CEC401	Engineering Mathematics-IV	20	20	20	80	03	25	-	125
CEC402	Structural Analysis	20	20	20	80	03	-	-	100
CEC403	Surveying	20	20	20	80	03	-	-	100
CEC404	Building Materials & Concrete Technology	20	20	20	80	03	-	-	100
CEC405	Fluid Mechanics-II	20	20	20	80	03	-	-	100
CEL401	Structural Analysis	-	-	-	-	-	25	25	50
CEL402	Surveying	-	-	-	-	-	50	25	75
CEL403	Building Material Concrete Technology	-	-	-	-	-	25	25	50
CEL404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL405	Skill Based lab Course - II	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1B	-	-	-	-	-	25	25	50
Total		100			400	-	225	125	850

\$ indicates work load of Learner (Not Faculty), for Mini Project.

Undergraduate Program Structure for Third year Civil Engineering

University of Mumbai

(With Effect from A. Y. 2021-2022)

Semester - V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC501	Theory of Reinforced Concrete Structures	03	-	-	03	-	-	03
CEC502	Applied Hydraulics	03	-	-	03	-	-	03
CEC503	Geotechnical Engineering-I	03	-	-	03	-	-	03
CEC504	Transportation Engineering	04	-	-	04	-	-	04
CEDLO501X	Department Level Optional Course-1	03	-	-	03	-	-	03
CEL501	Theory of Reinforced Concrete Structures	-	02	-	-	01	-	01
CEL502	Applied Hydraulics	-	02	-	-	01	-	01
CEL503	Geotechnical Engineering-I	-	02	-	-	01	-	01
CEL504	Transportation Engineering	-	02	-	-	01	-	01
CEL505	Professional Communication and Ethics-II	-	02*+2	-	-	02	-	02
CEM501	Mini Project – 2A	-	04\$	-	-	02	-	02
Total		16	16	-	16	08	-	24

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC501	Theory of Reinforced Concrete Structures	20	20	20	80	03	-	-	100
CEC502	Applied Hydraulics	20	20	20	80	03	-	-	100
CEC503	Geotechnical Engineering-I	20	20	20	80	03	-	-	100
CEC504	Transportation Engineering	20	20	20	80	03	-	-	100
CEDLO501X	Department Level Optional Course -1	20	20	20	80	03	-	-	100
CEL501	Theory of Reinforced Concrete Structures	-	-	-	-	-	25	25	50
CEL502	Applied Hydraulics	-	-	-	-	-	25	25	50
CEL503	Geotechnical Engineering-I	-	-	-	-	-	25	25	50
CEL504	Transportation Engineering	-	-	-	-	-	25	25	50
CEL505	Professional Communication and Ethics-II	-	-	-	-	-	25	25	50
CEM501	Mini Project – 2A	-	-	-	-	-	25	25	50
Total		100			400	-	150	150	800

* Theory class to be conducted for full class

\$ indicates work load of Learner (Not Faculty), for Mini Project

Undergraduate Program Structure for Third year Civil Engineering
University of Mumbai
(With Effect from A.Y. 2021-2022)
Semester - V

Department Level Optional Course – 1

Sr. No.	Course Code CEDLO501X	Department Level Optional Course – 1
1	CEDLO5011	Modern Surveying Instruments and Techniques
2	CEDLO5012	Building Services & Repairs
3	CEDLO5013	Sustainable Building Materials
4	CEDLO5014	Advanced Structural Mechanics
5	CEDLO5015	Air and Noise Pollution & Control
6	CEDLO5016	Transportation Planning & Economics
7	CEDLO5017	Advanced Concrete Technology

Undergraduate Program Structure for Third year Civil Engineering
University of Mumbai
 (With Effect from A.Y. 2021-2022)
Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC601	Design & Drawing of Steel Structures	03	-	-	03	-	-	03
CEC602	Water Resources Engineering	03	-	-	03	-	-	03
CEC603	Geotechnical Engineering-II	03	-	-	03	-	-	03
CEC604	Environmental Engineering	04	-	-	04	-	-	04
CEDLO601X	Department Level Optional Course -2	03	-	-	03	-	-	03
CEL601	Design & Drawing of Steel Structures	-	02	-	-	01	-	01
CEL602	Water Resources Engineering	-	02	-	-	01	-	01
CEL603	Geotechnical Engineering-II	-	02	-	-	01	-	01
CEL604	Environmental Engineering	-	02	-	-	01	-	01
CEL605	Skill Based Lab Course – III	-	03	-	-	1.5	-	1.5
CEM601	Mini Project – 2B	-	03 ^{\$}	-	-	1.5	-	1.5
Total		16	14	-	16	07	-	23

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test – I	Test - II	Avg.					
CEC601	Design & Drawing of Steel Structures	20	20	20	80	04	-	-	100
CEC602	Water Resources Engineering	20	20	20	80	03	-	-	100
CEC603	Geotechnical Engineering-II	20	20	20	80	03	-	-	100
CEC604	Environmental Engineering	20	20	20	80	03	-	-	100
CEDLO601X	Department Level Optional Course -2	20	20	20	80	03	-	-	100
CEL601	Design & Drawing of Steel Structures	-	-	-	-	-	25	25	50
CEL602	Water Resources Engineering	-	-	-	-	-	25	25	50
CEL603	Geotechnical Engineering-II	-	-	-	-	-	25	25	50
CEL604	Environmental Engineering	-	-	-	-	-	25	25	50
CEL605	Skill Based Lab Course-III	-	-	-	-	-	25	25	50
CEM601	Mini Project – 2B	-	-	-	-	-	25	25	50
Total		100			400	-	150	150	800

\$ indicates work load of Learner (Not Faculty), for Mini Project.

Undergraduate Program Structure for Third year Civil Engineering

University of Mumbai

(With Effect from A. Y. 2021-2022)

Semester - VI

Department Level Optional Course – 2

Sr. No.	Course Code CEDLO601X	Department Level Optional Course – 2
1	CEDLO6011	Rock Mechanics
2	CEDLO6012	Biological Processes & Contaminant Removal
3	CEDLO6013	Construction Equipment & Techniques
4	CEDLO6014	Urban Infrastructure Planning
5	CEDLO6015	Open Channel Flow
6	CEDLO6016	Computational Structural Analysis
7	CEDLO6017	Traffic Engineering and Management
8	CEDLO6018	Introduction to Offshore Engineering

Program Structure for Third Year Engineering

Semester VII & VIII

UNIVERSITY OF MUMBAI

(With Effect from 2022-2023)

Semester - VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC701	Design & Drawing of Reinforced Concrete Structures	03	-	-	03	-	-	03
CEC702	Quantity Survey, Estimation and Valuation	03	-	-	03	-	-	03
CEDLO701X	Department Level Optional Course – 3	03	-	-	03	-	-	03
CEDLO702X	Department Level Optional Course – 4	03	-	-	03	-	-	03
CEILO701X	Institute Level Optional Course – 1	03	-	-	03	-	-	03
CEL701	Design & Drawing of Reinforced Concrete Structures	-	02	-	-	01	-	01
CEL702	Quantity Survey, Estimation and Valuation	-	02	-	-	01	-	01
CEP701	Major Project – I	-	06 ^{\$}	-	-	03	-	03
Total		15	10	-	15	05	-	20

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC701	Design & Drawing of Reinforced Concrete Structure	20	20	20	80	04	-	-	100
CEC702	Quantity Survey, Estimation and Valuation	20	20	20	80	04	-	-	100
CEDLO701X	Department Level Optional Course – 3	20	20	20	80	03	-	-	100
CEDLO702X	Department Level Optional Course – 4	20	20	20	80	03	-	-	100
CEILO701X	Institute Level Optional Course – 1	20	20	20	80	03	-	-	100
CEL701	Design & Drawing of Reinforced Concrete Structure	-	-	-	-	-	25	25	50
CEL702	Quantity Survey, Estimation and Valuation	-	-	-	-	-	25	25	50
CEP701	Major Project – I	-	-	-	-	-	50	-	50
Total		100			400	-	100	50	650

\$ indicates work load of Learner (Not Faculty), for Major Project.

Undergraduate Program Structure for Final year Civil Engineering

University of Mumbai

(With Effect from A.Y. 2022-2023)

Semester - VII

Department Level Optional Course – 3

Sr. No.	Course Code CEDLO701X	Department Level Optional Course – 3
1	CEDLO7011	Prestressed Concrete
2	CEDLO7012	Applied Hydrology and Flood Control
3	CEDLO7013	Appraisal and Implementation of Infra Projects
4	CEDLO7014	Analysis of Offshore Structures
5	CEDLO7015	Advanced Construction Technology
6	CEDLO7016	Pavement Materials Construction and Maintenance

Department Level Optional Course – 4

Sr. No.	Course Code CEDLO702X	Department Level Optional Course – 4
1	CEDLO7021	Foundation Analysis and Design
2	CEDLO7022	Solid hazardous waste management
3	CEDLO7023	Ground Improvement techniques
4	CEDLO7024	Green building constructions
5	CEDLO7025	Legal Aspects in constructions
6	CEDLO7026	Environmental impact assessment
7	CEDLO7027	Advanced Steel Structures

Institute Level Optional Course – I

Sr. No.	Course Code CEILO701X	Institute Level Optional Course – I
1	CEILO7011	
2	CEILO7012	

3	CEILO7013	

Undergraduate Program Structure for Final year Civil Engineering
University of Mumbai
(With Effect from A. Y. 2022-2023)
Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC801	Construction Management	03	-	-	03	-	-	03
CEDLO801X	Department Level Optional Course – 5	03	-	-	03	-	-	03
CEDLO802X	Department Level Optional Course – 6	03	-	-	03	-	-	03
CEILO801X	Institute Level Optional Course – 2	03	-	-	03	-	-	03
CEL801	Construction Management	-	02	-	-	01	-	01
CEP801	Major Project – II	-	12 ^{\$}	-	-	06	-	06
Total		12	14	-	12	07	-	19

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test - I	Test – II	Avg.					
CEC801	Construction Management	20	20	20	80	03	-	-	100
CEDLO801X	Department Level Optional Course – 5	20	20	20	80	03	-	-	100
CEDLO802X	Department Level Optional Course – 6	20	20	20	80	03	-	-	100
CEILO801X	Institute Level Optional Course – 2	20	20	20	80	03	-	-	100
CEL801	Construction Management	-	-	-	-	-	25	25	50
CEP801	Major Project – II	-	-	-	-	-	50	100	150
Total		80			320	-	75	125	600

\$ indicates work load of Learner (Not Faculty), for Major Project.

Undergraduate Program Structure for Final year Civil Engineering

University of Mumbai

(With Effect from A.Y. 2022-2023)

Semester VIII

Department Level Optional Course – 5

Sr. No.	Course Code CEDLO801X	Department Level Optional Course – 5
1	CEDLO8011	Bridge Engineering
2	CEDLO8012	Design of Hydraulics Structures
4	CEDLO8013	Construction Safety
5	CEDLO8014	Pavement Design
6	CEDLO8015	Industrial Waste Treatment
7	CEDLO8016	Soil Dynamics

Department Level Optional Course – 6

Sr. No.	Course Code CEDLO802X	Department Level Optional Course – 6
1	CEDLO8021	Repairs, Rehabilitation and Retrofitting of structures
2	CEDLO8022	Physio-Chemical Properties of Waste And Sewage Water
3	CEDLO8023	Transportation System Engineering
4	CEDLO8024	Smart Building Materials
5	CEDLO8025	Structural Dynamics
6	CEDLO8026	Ground Water Engineering

Institute Level Optional Course-2

Sr. No.	Course Code CEILO801X	Institute Level Optional Course-2

1	CEILO8011	
2	CEILO8012	
3	CEILO8013	

Faculty may design and conduct practicals for elective subjects wherever possible, under the head 'content beyond syllabus'.

Semester V

Semester-V

Course Code	Course Name	Credits
CEC501	Theory of Reinforced Concrete Structures	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Working Stress Method (WSM) makes use of the concept of modular ratio based on the higher factor of safety in evaluating the stresses in two different materials of the RCC i.e., steel and concrete. The Limit State Method (LSM) is based on the statistical probability which provides the rational solution to the design problems. The philosophy which lies behind, LSM uses multiple safety factors format which attempts to provide adequate safety at the ultimate load as well as adequate serviceability at service load by considering all possible limit states. The subject involves the application of working stress method and limit state method in the analysis and design of various elements of the civil engineering structures.

Objectives

- 1 To develop clear understanding of design philosophy amongst the students for the design of reinforced concrete structure using working stress method (WSM) and limit state method (LSM).
- 2 To study various clauses of IS: 456-2000 and their significance in the RCC design.
- 3 To apply various concepts of LSM in the analysis and design of beams, slabs and columns.
- 4 To study the concept of Serviceability and Durability for deflection and crack width calculation in RCC structures.
- 5 To develop the concept of design using design charts and curves for columns subjected to axial load and moment.
- 6 To study the concept of reinforced concrete footing design subjected to axial load and moment.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Working Stress Method:		06
	1.1	Concept of reinforced concrete, Working Stress Method (WSM) of design for reinforced concrete, permissible stresses as per IS:456-2000; stress- strain curve of concrete and steel, characteristics of concrete and steel reinforcement.	
	1.2	Concept of balanced, under reinforced and over reinforced sections.	
	1.3	Analysis and design of singly reinforced and doubly reinforced rectangular beams for Flexure.	
2	Limit State Method:		03
	2.1	Introduction to limit state method of design as per IS:456-2000.	
	2.2	Concepts of probability and reliability, characteristic load, characteristic strength, partial safety factors for loads and materials, introduction to various limit states of collapse and serviceability.	
3	Limit State of Collapse: Flexure, Shear, Bond and Torsion:		12
	3.1	Design of singly and doubly reinforced Rectangular and Flanged sections for flexure, shear and bond.	
	3.2	Design of beams subjected to bending, shear and torsion.	
4	Design of Slabs using Limit state method:		04
	4.1	Design of simply supported one-way slabs as per IS:456-2000.	
	4.2	Design of simply supported two-way slabs as per IS:456-2000.	
5	Limit State of Collapse – Compression:		08
	5.1	Limit state of collapse: compression for short and slender column.	
	5.2	Introduction to Members subjected to combined axial and uniaxial as well as biaxial bending.	
	5.3	Development of interactive curves and their use in column design.	
6	Design of Foundations:		06
	6.1	Design of Isolated square and rectangular footings subjected to axial load and moment.	
	6.2	Introduction to basic concepts of combined rectangular pad footing, slab beam type footing and Raft foundation.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

1. Understand the fundamentals of WSM and LSM.
2. Apply various clauses specified in IS: 456-2000 for designing structural members with safety and economy.
3. Understand the use of readymade design charts and curves from Special Publications of Bureau of Indian Standards.
4. Analyze and design various reinforced concrete elements such as beam, slab, column, footings using the concept of Limit State Method.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. **Use of IS:456-2000 shall be allowed in the examination.**
2. Question paper will comprise of total six questions, each carrying 20 marks.
3. Question 1 will be compulsory and should cover maximum contents of the curriculum.
4. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
5. Four questions need to be solved in total.

Recommended Books:

1. Design of Reinforced Concrete Structures: Dayaratnam, P; Oxford and IBH.
2. Limit State Design of Reinforced Concrete: Jain A. K, Nemchand and Bros., Roorkee
3. Limit State Design of Reinforced Concrete: Shah and Karve, Structure Publications, Pune.
4. Ultimate Strength Design for Structural Concrete: Arthur, P. D. and Ramakrishnan, V., Wheeler and Co. Pvt. Ltd.
5. Reinforced Concrete: H.J. Shah, Charotar Publishers, Anand.
6. Fundamentals of Reinforced Concrete: Sinha & Roy, S. Chand and Co. Ltd.
7. Illustrated Reinforced Concrete Design: Dr. V. L. Shah and Dr. S. R. Karve, Structure Publications, Pune.
8. Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A, John Wiley (2007), 7th Edition.
9. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.

Reference Books:

1. Design of RCC structural Elements (RCC Vol-I): Bhavikatti, S. S., New Age International Publications.
2. Reinforced Concrete: Syal and Goel; Wheeler Publishers.
3. Reinforced Concrete Design: Pillai, S.U. and Menon, Devdas, Tata Mc-Graw Hill Publishing House, New Delhi.
4. Reinforced Concrete Design by S.N. Sinha, Tata Mc-Graw Hill Publishing House, New Delhi
5. Theory of Reinforced concrete structures by N. Subramanian, Oxford University Press.
6. RCC Design (WSM and LSM): Punmia, B. C., Jain, A. K., and Jain, Arun, K., Laxmi Publications.
7. Limit State Design of Reinforced Concrete (as per IS: 456-2000): Punmia, B. C., Jain, A. K., and Jain, Arun, K., Laxmi Publications.
8. Relevant IS Codes: BIS Publications, New Delhi.

Semester-V

Course Code	Course Name	Credits
CEC502	Applied Hydraulics	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	

Rationale

The knowledge of this course is essential to understand facts, concepts of impact of jets, Miscellaneous Hydraulic Machinery. Further it helps to understand the design aspects, components, function and uses of centrifugal pump, turbines. It also helps to study the concept of uniform Flow Through Open Channels, Non-Uniform Flow Through Open Channels.

Objectives

The students will be able to learn:

- 1 To introduce the concept of impact of jets.
- 2 To study hydraulic machines like centrifugal pumps and turbines.
- 3 To study various Miscellaneous Hydraulic Machinery.
- 4 To study the uniform flow through open channels and design of most economical section.
- 5 To study the non-uniform flow through open channels.

Detailed Syllabus

Module	Course Module / Contents	Periods
1	Impact of Jets	07
	Impulse momentum principle, Jet striking flat plates, stationary and moving vertical, inclined plates, hinged plates, curved vanes, series of plates and vanes mounted on wheel, concept of velocity triangles.	
2	Hydraulic Turbines	08
	General layout of hydro-electric plant, heads, efficiencies of turbine, classification, concept of velocity triangles working of Impulse Turbine (Pelton Wheel), Reaction Turbine, Francis Turbine, Kaplan Turbine, draft tube theory, specific speed, unit quantities, Characteristic curves, Cavitation.	
3	Centrifugal Pumps	04
	Work done, heads, efficiencies, Minimum speed: series parallel operation, Multistage pumps, concept of velocity triangles, specific speed, model testing, priming, characteristic curves, NPSH, cavitation.	
4	Miscellaneous Hydraulic Machinery	03
	Hydraulic Ram, Press, Accumulator, Intensifier, Crane and Lift.	
5	Uniform Flow Through Open Channels	07
	Uniform Flow: Flow through open channel: Definition, types of channels, Prismatic, non-prismatic channels, Types of flows in channels, Uniform flow: steady flow and unsteady flow, laminar and turbulent flow, subcritical flow, supercritical flow, Chezy's formula, Manning's formula, hydraulically efficient channel cross-sections (most economical sections).	
6	Non-Uniform Flow Through Open Channels	10
	Concept of Specific energy and specific energy curve, Dimensionless specific energy discharge curve, applications of specific energy and Momentum principle to open channel flow, specific force. Gradually varied flow, equation for gradually varied flow, back water curve and afflux, Introduction to surface profiles, Hydraulic jump and standing wave.	
Total		39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Describe impact of jet on stationary, moving, hinged and series of plates also solve the numerical based on forces acting on it.
- 2 Distinguish various types of turbines, Characteristic curves and its components.
- 3 Analyze Centrifugal pumps by incorporating velocity triangle diagrams.
- 4 Know the working mechanism of various Hydraulic machines.
- 5 Identify the hydraulic behaviour of open channel flow and design the most economical section of channels.
- 6 Explain mathematical relationships for hydraulic jumps, surges, and critical, uniform, and gradually-varying flows.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only four questions need to be solved in total.

Recommended Books:

- 1 Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi.
- 2 Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
- 3 Fluid Mechanics: Dr. A.K Jain, Khanna Publishers.
- 4 Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538.
- 5 Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons.
- 6 Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.
- 7 Flow through open channels, K.G. Ranga Raju. (1993) : New Delhi : Tata McGrawHill, c1993.
- 8 Flow Through Open Channels. Rajesh Srivastava (2007): Oxford University Press, 2007, pbk, 432 p, ISBN: 0195690385.

Reference Books:

- 1 Fluid Mechanics: Frank M. White, Tata Mc-Graw Hill International Edition.
- 2 Fluid Mechanics: Streeter White Bedford, Tata Mc-Graw International Edition.
- 3 Fluid Mechanics with Engineering Applications: R.L. Daugherty, J.B. Franzini, E.J. Finnemore, Tata Mc-Graw Hill, New Delhi.
- 4 Hydraulics: James F. Cruise, Vijay P. Singh and Mohsen M. Sherif, CENGAGE Learning India (Pvt.) Ltd.
- 5 Introduction to Fluid Mechanics: Edward J. Shaughnessy, Jr, Ira M. Katz, James P. Schaffer. Oxford Higher Education.
- 6 Open channel Hydraulics: Chow, V.T., McGraw Hill International, New York.
- 7 Open Channel Flow: Henderson F.M., McGraw Hill International, New York.

Semester-V

Course Code	Course Name	Credits
CEC503	Geotechnical Engineering-I	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Around all civil engineering structures are supported by soil and rock. Rock is rarely occurring and hence, mostly the supporting medium is soil. The stability of structure depends on the stability of supporting medium. Therefore, geotechnical analysis is required to be carried out. Geotechnical analysis depends on the basic understanding of physical properties of soil which are useful for determining the strength, compressibility, drainage characteristics etc. Soil mechanics is the basic tool for geotechnical engineering, which is the specialized section of civil engineering. Soil is also used as a construction material to build various civil structures, viz., dams, embankment etc. Thus, it is very essential to understand various concepts involved in this course of Geotechnical Engineering-I.

Objectives

- 1 To study origin and mode of formation of soil as well as functional relationships among different unit weights, volumetric ratios, and water content.
- 2 To study clay mineralogy and plasticity characteristics of soils.
- 3 To comprehend particle size distribution and classification of soils as per IS code.
- 4 To study permeability and seepage flow of water through the soil.
- 5 To understand the concept of total stress, neutral stress and effective stress in soil.
- 6 To understand compaction characteristics of soils as well as the techniques of soil exploration, assessing the subsoil conditions and engineering properties of various soil strata.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Introduction to Geotechnical Engineering, Basic Definitions & Relationships		07
	1.1	Definitions and scope of Geotechnical Engineering: rocks, soil, origin & mode of formation and types of soil obtained, soil mechanics, rock mechanics, geotechnical engineering.	
	1.2	Soil phase systems, volumetric ratios: void ratio, porosity, degree of saturation, air voids, air content.	
	1.3	Weight-volume relationship: different unit weights, water content, specific gravity of soil solids, mass and absolute specific gravity.	
	1.4	Functional relationships among different unit weights, volumetric ratios, and water content.	
	1.5	Relative density, relative compaction.	
	1.6	Different methods to determine water content, specific gravity and unit weight of soil.	
2	Clay Mineralogy and Plasticity Characteristics of Soils		06
	2.1	Explanation about clay minerals, e.g., Montmorillonite, Illite and Kaolinite; formation of clay minerals and their role in plastic behavior of soil.	
	2.2	Definition of plasticity of soil, consistency of soil, definition & determination of liquid limit, plastic limit, shrinkage limit.	
	2.3	Definitions of shrinkage parameters, plasticity index, liquidity index, consistency index, flow index, toughness index, activity, sensitivity and thixotropy of soil. Importance of consistency limits.	
3	Particle Size Distribution and Classification of Soils		06
	3.1	Wet & dry sieve analysis, Sedimentation analysis: Stoke's law, Hydrometer method of analysis, Limitation of sedimentation analysis.	
	3.2	Particle size distribution curve/ gradation curve and its uses. Introduction to cohesive and cohesionless soil.	
	3.3	Necessity of soil classification, Indian standard particle size classification, Indian standard soil classification system as per IS: 1498 -1970, boundary classification.	
4	Permeability of Soils & Seepage Analysis		08
	4.1	Types of soil water, definition of hydraulic head, hydraulic gradient, Darcy's law, validity of Darcy's law, permeability of soil.	
	4.2	Determination of coefficient of permeability of soil in lab using constant head and variable head methods, factors affecting permeability of soil, effect of permeability on various properties of soil, determination of in-situ permeability with pumping out and pumping in tests.	

	4.3	Permeability of stratified soil deposits.	
	4.4	Definition of seepage and its importance for the analysis & design of hydraulic structures, graphical representation of seepage by flow net diagram, definition of flow line, equipotential line, flow channel, flow field, characteristics of flow net, use of flow net, phreatic line.	
	4.5	Factor of safety against piping failure.	
5	Effective Stress Principle		05
	5.1	Definition of geostatic stresses, total stress, neutral stress/ pore water pressure, effective stress.	
	5.2	Effect of water table fluctuations, surcharge, capillary action, seepage pressure on effective stress; quick sand condition.	
6	Compaction of Soil & Soil Exploration		07
	6.1	Theory of compaction, determination of optimum moisture content (OMC) & maximum dry density (MDD) in laboratory by conducting the light and heavy compaction tests.	
	6.2	Factors affecting the compaction, effect of compaction on properties of soil, soil structure, placement water content, relative compaction, Proctor needle method for compaction.	
	6.3	Necessity of soil exploration, methods of soil investigation, methods of boring, disturbed and undisturbed soil samples, soil sampling and samplers, number and spacing of bore holes, depth of bore holes.	
	6.4	Penetrometer tests: SPT, SCPT and DCPT.	
	6.5	Representation of data with borehole logs.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Explain the basic concepts of the physical and engineering properties of soil and derive the relationships among various unit weights & other parameters.
- 2 Comprehend clay mineralogy and plasticity behavior of clay.
- 3 Analyze grain size distribution of soil and classify the soil as per IS code.
- 4 Evaluate the coefficient of permeability of different types of soils and draw the flow net diagram to estimate seepage discharge.
- 5 Compute the effective stress and pore water pressure inside the soil mass under different geotechnical conditions.
- 6 Evaluate the compaction parameters in laboratory and field as well as understand the necessity and methods of soil exploration.

Internal Assessment**20 Marks**

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination**80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only four questions need to be solved in total.

Recommended Books:

- 1 Basic and Applied Soil Mechanics: Gopal Ranjan, A S R Rao; New Age International Publishers.
- 2 Soil Mechanics and Foundation Engineering: V. N. S. Murthy; CBS Publishers & Distributors
- 3 Soil Mechanics and Foundation Engineering: K. R. Arora; Standard Publishers and Distributors, New Delhi.
- 4 Soil Mechanics and Foundations: B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain; Laxmi Publications (P) LTD., New Delhi
- 5 Geotechnical Engineering: C. Venkatramaiah; New Age International Private Limited
- 6 Fundamentals of Soil Engineering: D. W. Taylor; John Wiley & Sons.

Reference Books:

- 1 An Introduction to Geotechnical Engineering: Robert D. Holtz, William D. Kovacs; Prentice-Hall, New Jersey
- 2 Soil Mechanics: R. F. Craig; Spon Press, Taylor and Francis Group
- 3 Soil Mechanics: T. W. Lambe, R. V. Whitman; John Wiley & Sons
- 4 Relevant Indian Standard Specifications Codes, BIS Publications, New Delhi
- 5 Soil Mechanics in Engineering Practice: Karl Terzaghi, Ralph B Peck, Gholamreza Mesri; John Wiley & Sons

Semester-V

Course Code	Course Name	Credits
CEC504	Transportation Engineering	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
04	-	-	04	-	-	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

An efficient transportation system is essential for sustainable economic development of the country and plays a significant role in promoting national and global integration. An efficient Transportation system helps in increasing productivity and enhances competitiveness of the economy. Hence, the transport sector is considered as an important component of the economy and a common tool used for development. Three basic modes of transportation include land, water and air. The course deals with understanding of basics of different modes of transportation (Highways, railways, airways and waterways). The highways owing to its flexibility in catering door-to-door service is one of the important modes. This course deals with the investigation, planning, design, construction and maintenance of highways in addition to traffic planning, operation and control.

Objectives

- 1 To understand the technical aspects of Railways, Airways and Waterways.
- 2 To carry out Planning and design of geometric elements of Highways.
- 3 To study various traffic studies and to understand elements of Traffic Engineering for efficient planning and control.
- 4 To study Requirements of Highway materials and to design Rigid and flexible pavements using IRC codes.
- 5 To study methods of construction of Rigid and Flexible pavements, use of soil stabilization and drainage to highways.
- 6 To design the overlay on basis of pavement evaluation and failure identification on rigid and flexible pavements.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Introduction to Transportation Systems		10
	1.1	Introduction to Transportation Engineering, Comparison of various modes of transportation (Roadways, Railways, Airways and Waterways).	
	1.2	Introduction to Railway Engineering: Cross sectional elements of railway track (Foundation, Ballast, Sleepers and Rail), Introduction to turnout, Super elevation design, Negative Super elevation, Construction and Maintenance of Railway track.	
	1.3	Introduction to Airport Engineering: Elements of Airport, Site selection of Airport, Design of Runway length, Taxiway and Exit Taxiway design.	
	1.4	Introduction to Waterways: Definition of Docks, Harbor and Ports. Elements and types of Docks, Harbor and Port.	
2	Planning and Geometric Design of Highways		10
	2.1	Classification of roads based on various criteria, Road development plans, agencies related to highway development, Highway alignment (basic requirement and factors governing), hill roads, Surveys for highway location.	
	2.2	Terrain Classification, Vehicular Characteristics, Cross section elements of highways (width of carriage way, shoulders, medians, width of road way, right of way, camber & its profile).	
	2.3	Design speed, sight distance, perception time, break reaction time, analysis of safe sight distance, analysis of overtaking sight distance, intersection sight distance.	
	2.4	Horizontal curves: design of super elevation, its provisions, minimum radius of horizontal curves, widening of pavement, transition curves.	
	2.5	Gradients: different types, maximum, minimum, ruling exceptional, grade compensation on curves.	
3	Traffic Engineering		10
	3.1	Introduction to various traffic studies such as speed study, volume study, parking study, accident study, O&D study etc. Speed study: methods to determine speed, types of speed (Spot speed, Design speed, Upper & lower limit speeds, Mean - Median and Modal speed); Traffic Volume study (flow): Definition, AADT, ADT, Design volume, methods of determining traffic volume. Traffic density: Definition, importance.	
	3.2	Introduction to Relationship between Speed, density and volume. Capacity: Q-K-V curve, Different types and factors affecting capacity, Concept of PCU and LOS.	
	3.3	Introduction to traffic control devices Traffic signs, signals (no design), road marking.	

	3.4	Different types of Intersections-At-grade and Grade Separated; Grade separated interchanges; rotary intersection.	
4	Pavement Material and Design		12
	4.1	Types of pavements, comparison of flexible and rigid pavements, Requirements of pavement materials, Soil: requirement of soils as subgrade material, CBR test. Aggregate: Requirements of aggregate as Pavement material, Tests on aggregate with specified values. Bitumen: Requirements of bitumen as pavement material test on bitumen with specified values, variants of bitumen (Modified bitumen) and its uses. Introduction to Bituminous mix design using Marshall Stability test.	
	4.2	Flexible pavement design: Concepts related to flexible pavement design such as tyre pressure, contact pressure, ESWL, VDF and LDF. IRC approach for design (IRC: 37- 2001, IRC: 37- 2012), also IRC SP 72-2007/2015 and IRC 77 2008.	
	4.3	Rigid pavement design: Modulus of subgrade reaction, equivalent radius of resisting section, radius of relative stiffness, stresses on rigid pavement, combine loading temperature stress.; Design of rigid pavements (IRC: 58- 2002; IRC: 58- 2011, IRC: 58- 2015. IRC: SP- 62-2004, IRC: SP- 62-2014)	
5	Pavement Construction, Soil Stabilization and Drainage		05
	5.1	Construction of different types of roads: water bound macadam (WBM) road, WMM, bituminous pavements, cement concrete pavement. And joint (As per IRC, MORTH specifications) jointed reinforced, continuously reinforced; fiber reinforced; roller compacted concrete pavements.	
	5.2	Soil Stabilization: Significance, Principle of soil stabilization, different methods of soil Stabilization, use of Geosynthetics in highways and allied structures.	
	5.3	Highway drainage: Necessity/ Significance, mode of ingress of water in highway structure, Different methods of drainage-surface and subsurface drainage inkling for the roads in hilly areas.	
6	Pavement Evaluation, Failures and Maintenance		05
	6.1	Evaluation of pavement, Structural and functional evaluation, methods of structural evaluation (working of Benkelman beam, FWD, LWD), methods of functional evaluation (working of Bump indicator, profilometric systems)	
	6.2	Distress / failure in Rigid and flexible pavement, reasons and measures.	
	6.3	Strengthening of existing pavement, Overlay and its types, design of overlay (Benkelman beam method)	
Total			52

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Compare various modes of transportation and understand basic technical aspects of railways, airways and waterways.
- 2 Understand different road plans, requirements of alignments and Design horizontal and vertical geometrical elements of highways.
- 3 Carry out different traffic studies and analyze basic parameters of traffic engineering for efficient planning and control of traffic.
- 4 Design the flexible and rigid pavement as per relevant IRC codes.
- 5 Construct different types of pavements, use of soil stabilization and planning of highway drainage.
- 6 Carry out structural and functional evaluation of pavement, identify the failures and design the overlay.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only four questions need to be solved in total.

Recommended Books:

- 1 A Course of Railway Engineering: Saxena, S. C. and Arora, S. P.; Dhanpat Rai Sons, New Delhi.
- 2 Airport Planning Design: Khanna, S.K., Arora, M.G. and Jain, J.J.; Nemchand Bros., Roorkee.
- 3 Docks and Harbour Engineering: Bindra, S. P.; Dhanpat Rai and Sons, New Delhi.
- 4 Highway Engineering: Khanna, S.K. and Justo, C. E. G.; Nem Chand and Bros., Roorkee.
- 5 Principles, Practice and Design of Highway Engineering (Including Airport Engineering) Sharma, S.K.; S. Chand and Company Pvt. Ltd., New Delhi.
- 6 Highway Material and Pavement Testing: Dr. S. K. Khanna, Dr. C. E. G. Justo and Dr. A. Veeraragavan. Nem Chand and Bros., Roorkee, India.

Reference Books:

- 1 Indian Railway Track: Agarwal, M. M., Suchdeva Press New Delhi.
- 2 Planning Design of Airport: Horonjeff Mckelrey, Tata Mc-Graw Hill India Publishing House, New Delhi.
- 3 Design and Construction of Ports and Marine Structures: Quinn, A. D., Tata Mc-Graw Hill India Publishing House.
- 4 Transportation Engineering and Planning: C.S. Papacostas and P.D. Prevedouros; Prentice Hall India Learning Pvt. Ltd., New Delhi.
- 5 Principles of Transportation Engineering: Chakraborty, Partha and Das, Animesh; Prentice Hall India Learning Pvt. Ltd., New Delhi.
- 6 Transportation Engineering: Khisty, C.J. and Lall, Kent, B.; Prentice Hall India Learning Pvt. Ltd., New Delhi.
- 7 Traffic Engineering and Transport Planning: Kadiyali, L.R., Khanna Publishers, Delhi.
- 8 Principles and Practice of Highway Engineering: Kadiyali, L. R.; Khanna Publishers, Delhi.
- 9 Relevant specifications of MORTH and relevant IRC codes.

Semester-V

Course Code	Course Name	Credits
CEDLO5011	Department Level Optional Course - 1 Modern Surveying Instruments and Techniques	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Revolutionary changes have taken place in the last few years in surveying instruments and techniques that are used for measuring level differences, distances, angles, areas, volumes, etc. This has become possible due to the advent of electronics in the surveying instruments. With rapid advancements in the technology and availability of cheaper and innovative electronic components, these instruments have become affordable and user friendly.

This course outlines the advancements in instruments and techniques such as digital levels, electronic distance measuring instruments, electronic theodolites, total stations, GPS, GIS, Remote Sensing, drone survey, aerial photogrammetry and hydrographic survey. It also makes the learner industry-ready with respect to the applications of the modern tools in data capturing and further in mapping using appropriate software.

Objectives

- 1 Understand the working principles and methodologies of modern surveying instruments and compare with conventional instruments.
- 2 Exhibit the concepts of Global Positioning System, Geographical Information system and remote sensing techniques.
- 3 Demonstrate the importance of Aerial photogrammetry in surveying works,
- 4 Develop recent methods of maintaining land records,
- 5 Study the art of delineating the levels underwater bodies.
- 6 Highlight the modern techniques in the field of surveying and mapping using various softwares.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Introduction to Modern Surveying Instruments:		06
	1.1	Principles governing modern instruments and comparison with the conventional instruments.	
	1.2	E.D.M. Electromagnetic spectrum, Electromagnetic distance measurement, Instruments – Digital planimeter, Auto Level, Laser Level, Electronic Digital Theodolite, Total Station, Scan station, Smart Station (Total station with GPS).	
2	Geoinformatics		12
	2.1	Global Positioning System- Global Positioning System – working principle and methods, Different Approaches to use GPS and their accuracies, Advantages of GPS in Navigation, Survey, Planning and Mapping.	
	2.2	Geographical Information System -Introduction, Definition, Objectives, Components (people, procedure, hardware, software & data) & functions (input, manipulation, management, query & analysis and visualization) of GIS. Coordinate systems and projections, Geo-referencing, GIS data – spatial (Raster & vector) & spatial data. Introduction to vector and raster data analysis such as network analysis, overlay analysis etc. for vector, DEM, Management of a spatial data.	
	2.3	Remote Sensing introduction, Definition, Necessity, Importance and use; Basic concepts in Remote Sensing, Basic Laws of electromagnetic radiation, Atmospheric effects on radiation, Interaction of EM energy with matter, Resolution in remote sensing, Satellite remote sensing, Problems confronting remote sensing system. Ideal and Real remote sensing systems.	
3	Aerial Photogrammetry		06
	3.1	Introduction, principle and uses of Aerial photographs, Definitions, of different terms, Scale of vertical and tilted photograph (simple problems), Ground Coordinates.	
	3.2	Relief Displacements, Ground control, Procedure of aerial survey, overlaps and mosaics, Stereoscopes	
4	Cadastral Surveying		04
	4.1	Cadastral Surveying: Contemporary Techniques of maintaining survey records, 7-12 Extracts, Form-8 (Namuna-8).	
	4.2	Role of Survey Department, Role of revenue department. Soft/digitized formats of land records, Comparison with conventional record keeping	
5	Hydrographic Surveying		04
	5.1	Hydrographic Surveying: Objects, Applications, establishing controls, Shore line survey, Sounding, sounding equipment, Methods of locating soundings – conventional and using GPS.	

	5.2	Reduction of soundings, Plotting of soundings, Nautical sextant and its use, Tides and tide gauges, determination of MSL.	
6	Applications of Modern Survey Techniques and Map Preparation Using Software		07
	6.1	Applications of Total Station, GIS, GPS, Remote sensing LIDAR, Drones in Civil Engineering.	
	6.2	Introduction of GRAM++, Q-GIS, Map Info etc.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Compare modern surveying instruments with conventional instruments.
- 2 Elucidate the utility of geoinformatics in surveying data collection and analysis.
- 3 Explain the utility of Aerial photogrammetry in surveying works.
- 4 Highlight the improvement in land record keeping and governance using modern tools.
- 5 Describe the procedure of hydrographic surveying and mapping.
- 6 Apply modern surveying tools to solve complex problems and demonstrate essential skills for working on surveying software.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only four questions need to be solved in total.

Recommended Books:

- 1 Agor R, Advanced Surveying, Khanna Publishers, New Delhi (ISBN9788174909053).
- 2 Kanetkar, T.P. and Kulkarni, S.V., Surveying and Levelling Vol. II, Pune Vidhyarthi Gruh Publication (ISBN9782508807185).
- 3 Arora, K.R., Surveying Vol. III, Standard Book House. New Delhi (ISBN9788189401276).
- 4 Basudeb Bhatta, Remote Sensing and GIS, Third Edition, Oxford University Press, New Delhi. ISBN: 9780199496648
- 5 B. C. Punmia, Ashok K Jain, Arun K Jain, Advance Surveying, Laxmi Publications (ISBN 9788170088530)
- 6 R. Subramanian, Surveying and levelling, Oxford University Press, New Delhi (ISBN9780198085423)
- 7 P.Dong , Q.Chen, Lidar Remote Sensing and applications ,CRC Press (ISBN 9781138747241)

Reference Books:

- 1 Basudeb Bhatta, Remote Sensing and GIS, Third Edition, Oxford University Press, New Delhi. ISBN: 9780199496648
- 2 T.M Lillesand, R.W Kiefer, and J.W Chipman, Remote sensing and Image interpretation, 5th edition, John Wiley and Sons, India; ISBN: 978-1-118-34328-9
- 3 Kaplan E.D and Hegarty C.J., Understanding GPS: principles and applications, Artech House (ISBN978-1-63081-058-0)
- 4 Wolf P.R. and Dewitt B.A., Elements of Photogrammetry, McGraw Hill,(ISBN 978-0072924541)
- 5 DeMers M.N., Fundamentals of GIS, John Wiley (ISBN978-0470129067)
- 6 Gibson P.J., Introductory Remote Sensing: Principles and Concepts, Routledge (ISBN0 415 18962 4).

Semester-V

Course Code	Course Name	Credits
CEDLO5012	Department Level Optional Course - 1 Building Services and Repairs	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

The building services are based on engineering operations of buildings & the built environment. Building services are responsible for the environment in which we live & work. Building service systems are complex. They are typically a major source of cost & potential problems in building service conditions. Fundamental knowledge of how mechanical, electrical, plumbing & other systems work & interact is important to the construction professionals. This course provides an introduction to building service systems which include the study of design, interfaces & specifications of various building services in buildings. For an existing building, it is necessary to be in a good condition to perform the intended functions. Adequate maintenance extends the building life & ensures the safety of occupants. Most of the structures are getting old & are in the dire need of the repair and maintenance. Hence, there is a huge employment potential in conformity with the field of repair and maintenance. This course, therefore, finds its place in the curriculum such that the pupils can acquire the competency in this area. The course deals with the different building services, health monitoring of buildings, their maintenance, repair materials and repair methodologies.

Objectives

- 1 To understand the concepts of mechanical systems in buildings such as lifts, escalators, HVAC systems, pumps & their applications.
- 2 To understand design concepts of electrical system, safety and illumination fundamentals.

- 3 To get familiar with the plumbing system and services in buildings related to water supply, drainage, gas supply and firefighting installations.
- 4 To learn about causes of distress of concrete structures and learn various instrumental testing methods for Condition assessment & evaluation of structure and assess the extent of repairs.
- 5 To acquire the knowledge of repair materials and repair methodologies for rehabilitation of RCC structures.
- 6 To learn implementing repair process and to follow safety during construction work.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Building services: Mechanical systems.		06
	1.1	Lifts/elevators, escalators, conveyors: their components, capacity and principles of working, common problems.(3L)	
	1.2	Motors, Generators, Pumps, HVAC Systems - Heating systems, Cooling Systems, Packaged HVAC, types, capacity, components and their principles of working, common problems.(3L)	
2	Building services: Electrical systems & Illumination in Buildings		07
	2.1	Electrical grids and supply system: Layout of substations Transformers & switch gears, Main & distribution boards, electrical systems in buildings, Single / Three phase supply, ISI specifications, electrical load, electrical layout plan in a building, Types of wires, wiring system & their choice, Solar energy, CCTV, LAN. Protective devices in electrical installation: Earthing for safety, Types of Earthing, fuses, circuit breakers, lightening arrester.(4L)	
	2.2	Principles of Illumination Design: Visual task, Factors affecting visual task, Luminous flux, candela, solid angle illumination, utilization factor. Modern theory of light & color: Synthesis of Light, Additive & Subtractive synthesis of colour, classification of lighting, artificial lights sources, spectral energy distribution, luminous efficiency, color temperature, colour rendering. Level of illumination: Lighting for stores, offices, school, hospitals and house lighting, elementary idea of special features required and minimum level of illumination required in buildings.(3L)	
3	Building services: Plumbing Systems in Building		06
	3.1	Water Distribution system: Material for service pipes, service connection, size of service pipe, Water meter, valves and storage tanks, water requirement for domestic use and firefighting.(2L)	

	3.2	Drainage system: Pipe and traps, system of plumbing, house drainage plans, Chambers- gradient and spacing, manholes, septic tanks and soak pit, Introduction to rain water harvesting system.(2L)	
	3.3	Other plumbing systems: Fire safety, fire-fighting installations, types and purpose, piped gas supply systems, AC ducting.(2L)	
4	Deterioration of Concrete Structures & Condition assessment		06
	4.1	Durability & Causes of deterioration of concrete structures: effects of climate, moisture, temperature, chemical, wear, erosion & loading on serviceability & durability. Design errors & construction errors, causes of seepage & leakage in concrete structures, formation of cracks including those due to corrosion.(2L)	
	4.2	Condition Survey, Evaluation & Damage Assessment: Structural audit and bye laws. Diagnostic methods & analysis. Destructive, semi-destructive and non-destructive methods: core test, carbonation test, chloride test, petrography, corrosion analysis, cover meter test, rebound hammer test, ultrasonic pulse velocity test, and crack measurement techniques, Concrete endoscopy & thermal imaging, pull- off test & pull-out test.(4L)	
5	Repair Materials & Methodologies For Repairs		08
	5.1	Repair analysis, Repair materials: and their desired properties, Polymer modified mortar/ concrete, micro concrete, bonding chemicals, protective materials and their properties for moisture barrier systems, water-proofing of concrete structures, Systems like integral, crystalline, coatings, membranes, joints sealants, crack repair fillers, corrosion resistant steels, Pre-packed zinc sacrificial anode, Snap-On zinc mesh anode CP system, corrosion inhibitors, rust solvents.(4L)	
	5.2	Repair methodologies: Crack and patch repair, Injection grouting, surface coatings, column jacketing, guniting shotcrete, Ferroconcrete, FRP, Carbon fiber wrapping, methods of rebar corrosion protection, cathodic protection.(4L)	
6	Repair Process Implementation and Safety During Repairs		06
	6.1	Legal Documentation and Records: Estimates of repair work, procedure and flow chart for repairs, Bill of quantities, Tendering, Work order, Agreement and Contract, Measurement book, bills, security deposits, role of PMC.(3L)	
	6.2	Safety during Repairs: Causes of accidents, safety signs, barricading, insurance, Temporary Support structures such as, formwork, shuttering, centering, staging and scaffolding.(3L)	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Apply the knowledge of working & installation of mechanical utility services in buildings.
- 2 Understand the electrical supply lines, materials, safety devices and illumination systems used in buildings.
- 3 Investigate and learn operations and adopt appropriate materials in plumbing systems & integrate the same into the building projects.
- 4 Assess the structural health of the buildings & adopt repair strategy to the damaged structures.
- 5 Implement the right methods and materials for repairing the concrete structures and also decide the sequence of operations.
- 6 Create and understand proper documentation process and adopt practices for safety for protection of men and materials on the repair site.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only four questions need to be solved in total.

Recommended Books:

- 1 Heat Pumps and Electric Heating: *E. R. Ambrose*, John and Wiley and Sons, Inc., New York, 1968
- 2 Handbook for Building Engineers in Metric Systems, NBC, New Delhi, 1968.
- 3 Philips Lighting in Architectural Design, McGraw-Hill, New York, 1964.
- 4 The Lighting of Buildings: *R. G. Hopkinson and J. D. Kay*, Faber and Faber, London, 1969.
- 5 National Building Code.
- 6 Building Construction: *Dr. B. C. Punmia, Ashok K Jain, A.K Jain*
- 7 Construction Engineering and Management: *S. Seetharaman*, Umesh Publications, Delhi.
- 8 Water supply and Sanitary Installations: *A. C. Panchdhari*, New Age International Publication, Delhi

- 9 Concrete Repair and Maintenance: *Peter H. Emmons and Gajanan M. Sabnis*, Galgotia Publication
- 10 Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication.
Building Services and Repairs: Dr. A. S. Radke, Tech Knowledge Publications

Reference Books:

- 1 Guide to Concrete Repair and Protection, HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia
- 2 CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG (Works), CPWD, Government of India (Nirman Bhawan),
<http://www.cpwd.gov.in/handbook.pdf>.
- 3 Guide to Concrete Repair, *Glenn Smoak*, US Department of the Interior Bureau of Reclamation, Technical Service Center, <http://books.google.co.in>.
- 4 Management of Deteriorating Concrete Structures: *George Somerville*, Taylor and Francis publication
- 5 Concrete Building Pathology: *Susan Macdonald*, Blackwell Publishing.
- 6 Testing of Concrete in Structures: *John H. Bungey, Stephen G. Millard and Michael G. Grantham*, Taylor and Francis Publication.
- 7 Durability of concrete and Cement Composites: *Page, C.L.* and *Page, M.M.*, Woodhead Publishers
- 8 Fire Safety in Building: V. K. Jain, New Age International Publication, Delhi
- 9 MEP systems & Repairs of Buildings: A.S. Radke, Published by Synergy Knowledgeware.

Semester-V

Course Code	Course Name	Credits
CEDLO5013	Department Level Optional Course - 1 Sustainable Building Materials	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Meeting the needs of the present without compromising the ability of future generations to meet their needs is considered to be the simplest and effective sustainable development. The greatest threats to the sustainable development on earth are: population growth and urbanization, energy use and global warming, excessive waste generation and the subsequent pollution and limited supply of resources. Concrete is the primary construction material in the world. Construction industry consumes 40 percent of the total energy and about one half of world's major resources. Hence, it is imperative to regulate the use of materials and energy in this industry. The largest environmental impact of the concrete industry comes from the cement manufacturing process that leads to relatively high greenhouse gas emissions. Minimizing the quantity of cement in a concrete mix has many potential benefits. Thus, the use of industrial byproducts such as fly ash, silica fume as cementitious materials in concrete structures can lead to significant reduction CO₂ emissions and consumption of energy and raw materials. Green and intelligent buildings also have been evolved for sustainability of the construction industry. This course provides knowledge of different sustainable building materials and technologies in construction industry.

Objectives

- 1 To have more awareness among students about sustainability.
- 2 To understand environmental issues due to building materials and the energy consumption in manufacturing building materials.
- 3 To study the alternative masonry unit and mortar for sustainable practices.

- 4 To know the importance of cement reduction and replacements for a sustainable development.
- 5 To understand the alternative building technologies which are followed in construction.
- 6 To have cognizance of alternative roofing systems in practice.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Sustainability		07
	1.1	Introduction: Need and concept of sustainability, Social Environmental and economic sustainability concepts,	
	1.2	Sustainable development, Nexus between technology and Development, Challenges for sustainable development Fundamentals of sustainability.	
	1.3	Global Environmental issue: Resource degradation, ozone layer Depletion Climate change, Carbon cycle, Factors affecting Carbon credits and carbon trading, carbon foot Print, Carbon sequestration-carbon capture and storage (CCS).	
	1.4	Environment legislation in India-water act and air act	
2	Energy In Building Materials		06
	2.1	Embodied energy and life cycle energy, Calculation of embodied energy in wall, Environmental issues concerned to building materials, Global warming and construction industry.	
	2.2	Environment friendly and cost-effective building technologies. Requirements for building of different climatic regions.	
	2.3	Traditional building methods and vernacular architecture Green buildings, Intelligent buildings, green materials, green building ratings-IGBC & LEED.	
	2.4	Renewable and nonrenewable energy sources.	
3	Elements of Structural Masonry		06
	3.1	Characteristics of building blocks for walls, Stones and Laterite blocks, Bricks, Fly ash bricks and hollow clay blocks, Concrete Blocks, Stabilized blocks: mud blocks, steam cured blocks, Fal-G Blocks stone masonry block.	
	3.2	Masonry Mortars: Mortars, Cementitious materials: Lime, OPC, PPC, Masonry cement, Lime pozzolana (LP)cement. Sand: natural and manufactured, Classification of mortar as per BIS, Types of mortar, Properties and requirements of mortar, Selection of mortar.	
4	Cementitious and Supplementary Cementitious Materials and their Characterization:		06
	4.1	Lime, Lime pozzolana cements, Pozzolana: Surkhi, Fly ash, IS (3812) (Type C and F), GGBFS, Silica Fumes, Metakaolin,	

		RHA, Composite cements and its types, IS (16415:2015), Magnesia based cements, Calcium sulfo- cement, Alkali activated, cement (Type 1 and Type II), Geopolymers. Composition, Properties and uses.	
	4.2	Membrane curing: wax and resin based, self-curing compound: Polymer and polyethylene glycol, Water reducing admixtures, use of treated domestic effluent (TDE) for mixing and curing	
5	Alternate Building Technologies		07
	5.1	Fiber reinforced cement composites: Matrix materials, reinforcing Materials, Applications	
	5.2	Fiber reinforced polymer composites: Matrix materials, types of polymers used and applications	
	5.3	Ferrocement and ferroconcrete building components: Materials, Construction methods, Mechanical properties, Applications.	
	5.4	Nanotechnology for sustainable construction.	
6	Alternate Building Materials and Roofing Systems		07
	6.1	Building materials from agro and industrial waste: Typical agro- waste and biomass resources, Use of industrial waste: Fly ash, Blast furnace slag, Iron ore tailings, Gold mine tailings Granite and marble polishing fines, demolished building waste	
	6.2	Concepts in roofing alternatives, Types of roof, Roof as a structural system, Cost reduction through construction process efficiency	
	6.3	Filler slab roofs, Composite beam and panel roofs, construction Details and roof assembly.	
	6.4	Masonry domes and vaults: Relevance, analysis and design, Barrel vault.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Explain sustainable practices by utilizing engineering practices.
- 2 Able to understand different types of environmental problems and their sustainable solution.
- 3 Suggest appropriate type of masonry unit and mortar for civil engineering constructions.
- 4 Analyze different alternative building materials for construction.
- 5 To suggest suitable alternative building technologies for sustainable development.
- 6 To propose different roofing systems and use of waste materials in construction industry.

Internal Assessment**20 Marks**

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination**80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only four questions need to be solved in total.

Recommended Books:

- 1 Alternative Building Materials and Technologies by KS Jagadish, BV Venkatraman Reddy and KS Nanjunda Rao, New Age International publications.
- 2 Sustainability Engineering: Concepts, Design and Case studies by Allen D.T, and Shonnard D.R , Prentice Hall.
- 3 Sustainability Engineering: Concepts, Design and Case studies by Bradley A.S; Adebayo A.O, and Mario P., Cengage learning
- 4 Sustainability of construction materials by Jamal M Khatib, Woodhead publishing limited.
- 5 Renewable energy sources by Twidell J.W and Weir A.D, English Language Book Society (ELBS)

Reference Books:

- 1 ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy efficiency Publications—Rating system, TERI Publications – GRIHA Rating system.
- 2 Structural Masonry by Arnold W Hendry, Macmillan Publishers
- 3 Systems Analysis for Sustainable Engineering: Theory and Application by Ni bin Chang, Mc Graw Hill Professional
- 4 NPTEL course on sustainable materials and green building
<https://nptel.ac.in/courses/105/102/105102195>
- 5 Relevant codes

Semester-V

Course Code	Course Name	Credits
CEDLO5014	Department Level Optional Course - 1 Advanced Structural Mechanics	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

The structures are subjected to various types of loading/ forces. These are axial force, shear force, bending moment, torsion etc. This course enables the students with the knowledge in conformity with analysis of behaviour of structural members under different types of loading. The course facilitates in imparting theoretical concepts and physical understanding, which in turn will help in solving structural mechanics problems, mostly involving beams & thin-walled structures under different loading conditions.

Objectives

- 1 To understand the concept of unsymmetrical bending, shear centre and spring & evaluate the stress due to unsymmetrical bending, shear centre for symmetrical & un- symmetrical thin-walled sections.
- 2 To study the concepts and behavior of beams curved in elevation & to evaluate the stress.
- 3 To study the concepts and behavior of beams curved in plan subjected to different types of loadings.
- 4 To understand the concept & behavior of beams resting on elastic foundation.
- 5 To understand the concept of different theories of failure in regards of materials.
- 6 To study the behavior of deep beams using different theories available for the analysis of different sections.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Unsymmetrical Bending, Shear Centre and Springs		07
	1.1	Product of inertia, principal moment of inertia, flexural stresses due to bending in two planes for symmetrical sections, bending of unsymmetrical sections.	
	1.2	Shear Centre for symmetrical & unsymmetrical (about both axes) thin-walled open sections.	
	1.3	Helical springs, flat spiral springs, laminated springs.	
2	Beams Curved in Elevation		07
	2.1	Bending of beams with large initial curvature, loaded in their plane of curvature.	
	2.2	Application to analysis of hooks, circular closed rings, chain links with straight length & semi-circular ends.	
3	Beams Curved In Plan		05
	3.1	Analysis of Beams Curved in Plan such as cantilever circular arc, semicircular beams fixed at two ends and subjected to central concentrated load.	
	3.2	Simply supported semicircular beam subjected to UDL supported on three equally spaced columns, Analysis of circular ring beam.	
4	Beams on Elastic Foundation		07
	4.1	Analysis of beams of infinite length subjected to concentrated force/moment & semi-infinite length subjected to concentrated load/moment at one end.	
	4.2	Semi-infinite beam hinged at one end (origin) & subjected to UDL throughout.	
5	Theories of Failure		07
	5.1	Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory.	
	5.2	Maximum total strain energy theory.	
6	Analysis of Deep Beams		06
	6.1	Determination of deflection.	
	6.2	Determination of shear correction factor for various sections: rectangular solid & hollow section, circular solid & hollow section & I-section	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Understand the concept of unsymmetrical bending, shear centre for thin-walled open sections and springs.
- 2 Analyze hooks, circular closed rings, chain links with straight length & semi-circular ends using the concept of beam curved in elevation.
- 3 Analyze the beam curved in plan for different support conditions.
- 4 Study the behavior of beam resting on elastic foundation with various loading conditions.
- 5 Understand the concept of different theories of failure in different sections.
- 6 Determine deflection of deep beams, shear correction factor for different sections like solid & hollow sections.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only four questions need to be solved in total.

Recommended Books:

- 1 Mechanics of Materials: Popov, E.P. Prentice Hall of India Pvt. Ltd.
- 2 Advanced Mechanics of Materials: Arthur P. Boresi and Omar M. Sidebottom, Wiley and Sons.
- 3 Strength of Material Part I and Part II: Timoshenko, McGraw Hill, New York.
- 4 Mechanics of Solids: Shames, I and Pitarresi, J. M., Prentice Hall, New Delhi.
- 5 Strength of Materials: Subramanian, Oxford University Press.
- 6 Advanced Mechanics of Solids, L.S. Srinath, Tata McGraw Hill, 20
- 7 Strength of Materials: R. K. Rajput, S. Chand and Co. Ltd.

Reference Books:

- 1 Mechanics of Materials: Beer, F.P., E. Russell Johnston and John T. DeWolf, TMH, New Delhi.
- 2 Beams on Elastic Foundation: Heteny M.
- 3 Mechanics of Materials: James Gere, M., Thomson Brooks.
- 4 Reinforced Concrete Deep Beams: F.K. KONG, Taylor & Francis Books, Inc.

Semester-V

Course Code	Course Name	Credits
CEDLO5015	Department Level Optional Course - 1 Air and Noise Pollution and Control	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Air pollution is caused by solid and liquid particles and certain gases that are suspended in the air. These particles and gases can come from car and truck exhaust, factories, dust, pollen, mold spores, volcanoes and wildfires, possibly causing diseases, death to humans, damage to living organisms. Noise pollution impacts millions of people on a daily basis. The most common health problem it causes is Noise Induced Hearing Loss (NIHL). Exposure to loud noise can also cause high blood pressure, heart disease, sleep disturbances, and stress. This subject is intended to make students aware about the noise and air pollution, various sources which contribute in degradation of air quality, assessing the air quality through air quality index, and various air and noise pollution control methods and equipment used by industries.

Objectives

The students will be able to learn:

- 1 Understanding of basic concepts of air and noise pollution.
- 2 Study of air pollution episodes. Reasoning of the entire episode, identification of the parameters, conditions, mechanisms.
- 3 Study of sampling types and methods for ambient air and stack.
- 4 Study of macro and micro meteorology for understanding the dispersion of pollutants.
- 5 Simple and complex modeling for point source, line source and area source.
- 6 Study of pollution control methods, mechanism and devices, laws.

Detailed Syllabus

Module	Course Module / Contents	Periods
1	Introduction to Air Pollution: Definition, Air pollutants and its classification and sources of generation. Emission Inventory. Indoor air pollution. Measurement of air pollution. Air pollution in India and other countries. Air Quality Index. Numerical on conversion of units of pollutants.	05
2	Environmental Effects of Air Pollution: Effects of air pollutants on human beings, plants, animals, properties and visibility. Exposure to air pollution. Numerical problems based on COH, CoHb	06
3	Measurement and Control technology of Air Pollutants: methods to measure ambient air pollution and stack emissions, high volume sampler, wind rose diagram. Control Technology: Control Devices Principles, operations and types, simple hoods and ducts. Settling chambers, cyclones, electrostatic precipitators (ESP), Filters, scrubbers, absorption towers and incinerators. Collection efficiencies for laminar and turbulent flows for settling chambers, particle cut size for cyclone, ESP Concept of frictional and overall efficiencies. Design criteria for filters, scrubbers, absorption towers and incinerators.	10
4	Meteorological process and air quality monitoring: Large scale wind circulation geotropic wind, gradient wind, cyclone, anticyclone, planetary boundary layer. Lapse rate, stability conditions, wind velocity profile, maximum mixing depth, topographic effects. Plum patterns, plum dispersion, Gaussian model for predicting concentration, downwind from a single source, diffusion coefficients, Turner's stability categories and graphs for dispersion estimates. Maximum ground level concentration, inversion effects, distance touching ground modification of Gaussian model to predict particulate dispersion, plume rise, modified Holland equation for small source.	10
5	Current Issues on Air Pollution and Global -Legal Aspects, air pollution laws, Indian standards- emission and air quality standards Greenhouse effect/ Global warming, Ozone Pollution, Acid Rain.	04
6	Noise Pollution: definition and introduction, the effects of noise, characteristics of sound and its measurement, levels of noise and problems, noise rating system, noise level standards, sources of noise and their noise levels, noise abatement and control.	04
Total		39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Identify air and noise pollution problems and interpret criteria for air and noise quality data.
- 2 Recognize various environmental transformation processes of pollutants under extreme weather condition.
- 3 Interpret meteorological data and develop capability to assessment of project proposal.
- 4 Knowledge to analyze quality of air in the form of air quality index and dispersion modeling.
- 5 Relate and analyze the pollution regulation on its scientific basis.
- 6 Justify the use of pollution control equipment and their design.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only four questions need to be solved in total.
- 5 There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

Recommended Books:

- 1 Air Pollution: Rao. M. N. and Rao, H. V. N., Tata McGraw Hill Publication, New Delhi.
- 2 Environmental Pollution Control Engineering: Rao C.S., New Age International Publishers.
- 3 Noise Pollution: Agarwal S.K., APH Publishing Corporation.
- 4 Noise Pollution and Control Strategy: Singal S.P., Alpha Science International LTD.
- 5 Sewage disposal and Air pollution engineering: Garg, S.K., Khanna pbl.

Reference Books:

- 1 Air Pollution: Part A- Analysis and Part B-Prevention and Control: Ledbetter, J. O., Make Dekker Inc., New York.
- 2 Air Pollution: Wark and Warner, Harper and Row, New York.
- 3 Air Pollution Vol.1: Tripathi, A. K., Ashish Publication House, New Delhi.
- 4 Air Pollution Handbook: Magill, P. L. et al., McGraw Hill publication.
- 5 Air and Noise Pollution Control: Volume 1: Wang, L.K. and Pereira, N.C., Humana
- 6 Textbook of Noise Pollution and its Control: Bhatia S. C., Atlantic Publishers and Distributors, New Delhi.
- 7 Industrial Air Pollution Handbook: Parker, A., Tata McGraw Hills Publication.
- 8 Air Pollution: Henry Capeskins, McGraw Hill publication.
- 9 Environmental Noise Pollution: Noise Mapping, Public Health, and Policy, Enda Murphy and Eoin King.
- 10 Air Pollution: Wark and Warner, Harper and Row, New York.
- 11 Government of India's Publication of laws related to air pollution, Maharashtra Pollution Control Board's (MPCB) Publication of standards. Indian Standards relevant to Air Pollution Monitoring, Definitions, Standards.
- 12 Air Pollution Control Theory: Martin Crawford, McGraw Hill publication.

Semester-V

Course Code	Course Name	Credits
CEDLO5016	Department Level Optional Course - 1 Transportation Planning and Economics	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

The ultimate aim of Transport planning is to generate alternatives for improving Transportation system to meet future demand and selecting the best alternative after proper evaluation. The Course concentrates on Transportation system planning, Public Transportation Planning, Parking planning, and economic analysis of Transportation projects. Basic purpose of transportation planning is focusing on what's the most efficient movement for people and goods around the world. Improving access to an area not only reduces congestion, but the accessibility attracts new residents and businesses ultimately helping economic development.

Objectives

- 1 To understand various urban development policies in India and to learn different planning surveys.
- 2 To analyze and plan future traffic flow using four stage modelling.
- 3 To understand the implementation of land use transport model in Urban area.
- 4 To carry out economic analyses for different transportation infrastructure projects.
- 5 To understand and plan Urban public Transportation system.
- 6 To plan and design Parking system for residential, commercial and other projects.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Urban Transportation Planning		04
	1.1	Problems & factors in Transportation Planning, Development of Transportation Systems in India, Growth of Transport - Trends in Traffic - Imbalances in Transport System.	
	1.2	Urban growth mechanism – Urban morphology - Urbanization & travel demand - Urban development planning policy – NUTP - Urban transport projects - Urban transport problems in India	
	1.3	Urban travel patterns - Study area delineation- Zoning - Planning surveys - Urban activity system, Trip based and activity-based approach - Four stage travel demand modelling.	
2	Four Stage Modelling		10
	2.1	Trip generation analysis: trip classification, multiple regression analysis, category analysis	
	2.2	Trip distribution analysis: introduction, methods of trip distribution, uniform and average factor method, Fratar method, Furness method, the gravity model, opportunities model.	
	2.3	Modal split analysis: introduction, Modal split analysis modal split models.	
	2.4	Traffic Assignment: purpose of traffic assignment, Assignment techniques: All or nothing assignment, Multiple route assignment, Capacity restraint assignment, Diversion Curves.	
3	Land Use Transport Modelling		05
	3.1	Urban system components - Urban spatial structure – Accessibility - Location theory.	
	3.2	Land use models - Land use transport models, Lowry & Garin – Lowry models.	
4	Transportation Economics		10
	4.1	Economic evaluation of highway schemes, need for economic evaluation, cost and benefits of transportation projects	
	4.2	Basic principles of economic evaluation, Net present value method, benefit/cost ratio method, internal rate of return method. Vehicle operating costs.	
5	Urban Public Transport Planning		05
	5.1	Growth history – Urban growth & public transport needs - Modes of public transport and comparison - Public transport travel characteristics	
	5.2	Technology of bus, rail, rapid transit systems, and basic operating elements. Transit characteristics - Fleet size and capacity estimation.	
6	Parking Planning and Design		05

	6.1	Types of Parking's, Methods of surveys, Parking inventories, Parking Design	
	6.2	Planning of parking for residential and commercial buildings including shopping complex, malls and multiplex.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Understand various Urban transport related terms and policies along with methods to carry out planning surveys.
- 2 Carry out trip generation, trip distribution, modal split and traffic assignment for planning of urban transport system.
- 3 Apply land use transport models at Urban area.
- 4 Carry out economic analysis of different Transport related Infrastructure projects by analyzing costs and benefits related to projects using NPV, IRR and B/C ratio method.
- 5 Estimate capacity of different public transportation modes in Urban area and to plan and schedule the same based on fleet size.
- 6 Plan and design Parking facility at Urban area.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only four questions need to be solved in total.

Recommended Books:

- 1 Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2002.
- 2 IRC: SP: 30-1993., Manual on Economic Evaluation of Highway Projects in India.
- 3 Sarkar P K., Maitri V., Economics in Highway and Transportation Planning, Standard Publisher, New Delhi, 2010.
- 4 K.S. Ramegaula, Urban and Regional Planning, Mysore University Publication.
- 5 Ceder, A., Public Transit Planning and Operation: Theory, Modeling and Practice, B-H Elsevier Ltd., MA, 2007.
- 6 IRC:SP:12-2015, Guidelines for Parking Facilities in Urban Roads

Reference Books:

- 1 Khisty C J., Lall B.Kent, Transportation Engineering – An Introduction, Prentice-Hall, NJ, 2005
- 2 Ortuzar, J. D., Willumsen, L.G., Modeling Transport, John Wiley & Sons, 1994
- 3 Papacostas C.S. and Prevedouros, P.D., Transportation Engineering & Planning, PHI, New Delhi, 2002
- 4 Hutchinson B.G., Principles of Urban Transportation System Planning, Mc-Graw Hill, 1974.

Semester-V

Course Code	Course Name	Credits
CEDLO5017	Department Level Optional Course – 1 Advanced Concrete Technology	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Basic concept of concrete technology is essential for civil engineering students to execute the civil engineering projects as per the standard laid down time to time. Advancements in concrete technology is the backbone of infrastructure of civil engineering field. This course provides necessary knowledge about various concreting operations and testing operations during and after construction. This course is intended for gaining knowledge about the properties of materials, especially concrete and to maintain quality in construction projects. This course will also provide knowledge to the students about the criteria to be remembered during the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing.

Objectives

- 1 To understand the various properties and tests of materials used in concrete along with the rheology of fresh concrete.
- 2 To study the different procedures for testing hardened concrete, its compositions and quality of in place concrete.
- 3 To understand the concept of durability and cracking in concrete. To also understand the significance and parameters of concreting under extreme environment and conditions.
- 4 To understand the concept and optimization of the mix design of concrete by various codes.
- 5 To study the various constituents, properties, significance and applications of special concrete.
- 6 To study the quality of concrete and check the acceptance criteria.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Constituents and Properties Of Concrete		08
	1.1	Introduction of cement and water: Chemical composition of OPC, hydration, chemistry of cement, cement testing, water requirement for hydration, water quality for concrete and water quality test.	
	1.2	Aggregates: Types of aggregate (natural, synthetic, recycled), required characteristics of aggregates for concrete, introduction to gradation of aggregates, standard grading curve and gap grading.	
	1.3	Chemical admixture: Introduction to accelerators, retarders, plasticizers, super plasticizers, viscosity modifying admixtures, water proofers, miscellaneous admixtures.	
	1.4	Mineral admixture: Introduction, composition of mineral admixture, fly ash and its type, silica fume, ground granulated blast furnace slag and others. Effects of mineral admixture on fresh and hardened concrete properties.	
	1.5	Properties of fresh concrete: Introduction to properties of fresh concrete, w/c ratio, w/b ratio, gel space ratio, maturity concept, aggregate cement bond strength, pumping of concrete.	
	1.6	Rheological models of fresh concrete: Introduction, simple flow test, rheological models and test methods, factors affecting rheological properties of concrete and effect of rheological properties on different types of concrete.	
2	Testing of Concrete		05
	2.1	Introduction to testing of hardened concrete - compression, tension, and flexure. Methods of testing (destructive, semi destructive, non-destructive).	
	2.2	Properties of hardened concrete: Factors influencing strength, importance of end effects in compression testing, tensile strength of concrete (split and flexural), relationship between compressive and tensile strength.	
	2.3	Advanced non-destructive evaluation: Ground penetration radar, probe test penetration, pull out/off, break off method, stress wave propagation method, electrical / magnetic methods, infrared thermography, and core test.	
3	Durability of Concrete		10
	3.1	Introduction to durability and permeability: Transport mechanism of fluids and gases in concrete, role of w/c and admixture on durability. Design of durability using performance specification.	
	3.2	Corrosion and carbonation: Introduction to corrosion of reinforcement in concrete, factors influencing corrosion, damages preventive measures of corrosion, tests for existing structures and remedial measures of corrosion, introduction and measurement of depth of carbonation.	
	3.3	Concrete structures in special environment: Frost action, fire or	

		high temperature, chemical attack and aggressive environment (sulphate attack, chloride attack, acid attack in sewers, sea water attack), alkali aggregate reaction (alkali silica and carbonate reaction).	
	3.4	Concreting under extreme weather: Hot and cold weather concreting, underwater concreting.	
4	Concrete Mixture Design		07
	4.1	Design of concrete mixes by IS 10262 (latest edition) Method – with and without fly ash, super plasticizer, effect of pumping of concrete on mixture design.	
	4.2	Design of concrete mixes by American Concrete Institute (ACI) Method – Air and non-air entrained concrete.	
	4.3	Design of concrete mixes by Department of Environment (DoE) Method.	
	4.4	Design of concrete mixes by Road note 4 Method.	
	4.5	Design of high strength concrete mixes using ACI 211.4R - 93 Method.	
5	Special Concretes		06
	5.1	Light weight concrete and ultra-light weight concrete: Types and properties of light weight aggregates, factors influencing the strength and density of light weight aggregate concrete, properties of light weight aggregate concrete. Introduction to other light weight concrete – Cellular and foamed concrete. (01).	
	5.2	High performance concrete: Methods for achieving high performance concrete, requirements for high performance characteristics, material selection, advantages and applications.	
	5.3	Self-compacting concrete (SCC): Materials for SCC, comparison of traditional and SCC constituents, requirements for SCC, initial mix compositions, production and placing of SCC, fresh concrete tests for SCC.	
	5.4	Fiber Reinforced Concrete (FRC): Study of different fibers (metallic fiber, polymeric fibers, carbon fibers, glass fibers, naturally occurring fibers) in concrete with respect to volume fraction, orientation and aspect ratio, physical and mechanical properties - steel and polypropylene fiber reinforced concrete. Applications of steel and polypropylene fibers reinforced concrete.	
	5.5	Introduction to other special concrete – Vacuum concrete, waste material-based concrete, shotcrete, roller compacted, mass concrete.	
6	Quality Control (QC)		03
	6.1	Introduction: Statistical QC, quality factors, control charts.	
	6.2	Acceptance criteria according to Indian standards: Strength of concrete (site and laboratory)	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 To use the various concrete materials and demonstrate the fresh properties of concrete.
- 2 To perform different testing methods of concrete.
- 3 To describe the durability of concrete and apply the knowledge of durability in extreme weather concreting.
- 4 To design the concrete mix for field application by different methods.
- 5 To explain the various properties of special concrete.
- 6 To discuss the quality of concrete and explain the acceptance criteria.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only four questions need to be solved in total.

Recommended Books:

- 1 Concrete Technology: A. R. Shanthakumar, Oxford University Press, New Delhi, 2007.
- 2 Concrete Technology Theory and Practice: Shetty M.S., S. Chand.
- 3 Properties of concrete: Neville, Isaac Pitman, London.
- 4 Concrete Technology: Gambhir M.L., Tata McGraw Hill, New Delhi.
- 5 Concrete Technology: Neville A.M. & Brooks. J. J., ELBS-Longman, Pearson Education Ltd.
- 6 Relevant I.S. codes: Bureau of Indian standard and ACI code.
- 7 Design of concrete mixes by N Krishna Raju (Latest Edition), CBS Publishers and Distributors Pvt. Ltd.

Reference Books:

- 1 Fibre Reinforced Cementitious Composites: Arnon Bentur and Sidney Mindess, Modern Concrete Technology Series, Tylor and Francis.
- 2 Concrete- Microstructures, Properties and Materials: P. Kumar Mehta and Paulo J. M. Monteiro, Indian Edition, Indian Concrete Institute, Chennai, 1999
- 3 Special Publication of ACI on Polymer concrete and FRC.
- 4 Concrete Technology: D.F. Orchard, Wiley, 1962.
- 5 www.theconcreteportal.com

Semester-V

Course Code	Course Name	Credits
CEL501	Theory of Reinforced Concrete Structures (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

- 1 To develop a clear understanding of design philosophy amongst the students for the design of reinforced concrete structures using working stress method (WSM) and limit state method (LSM).
- 2 To study various clauses of IS: 456-2000 and their significance in the RCC design.
- 3 To apply various concepts of LSM in the analysis and design of beams, slabs and columns.
- 4 To study the concept of Serviceability and Durability for deflection and crack width calculation in RCC structures.
- 5 To develop the concept of design using design charts and curves for columns subjected to axial load and moment.
- 6 To study the concept of reinforced concrete footing design subjected to axial load and moment.

Course Outcomes:

At the end of the course, learner will be able to:

- 1 Understand the fundamentals of WSM and LSM.
- 2 Apply various clauses specified in IS: 456-2000 for designing structural members with safety and economy.
- 3 Understand the use of readymade design charts and curves from Special Publications of Bureau of Indian Standards.
- 4 Analyze and design various reinforced concrete elements such as beam, slab, column, footings using the concept of Limit State Method.

List of Tutorials and Assignments		
Week (Activity)	Detailed Content	Hours
1 st Week (Tutorial)	Analysis and Design of Singly and Doubly Reinforced RCC beam using WSM (Numericals Based on this module will be solved in tutorial class)	02
2 nd Week (Assignment)	Analysis and Design of Singly and Doubly reinforced RCC beam using WSM or any one activity from below: Solve set of Questions given by the course instructor. Write a report on provisions in IS 456 2000 related to the design of beams A comparative study consisting of advantages and disadvantages of WSM and LSM	02
3 rd Week (Tutorial)	Analysis and Design of Singly and Doubly Reinforced RCC beam using LSM. (Numericals Based on this module will be solved in tutorial class)	02
4 th Week (Assignment)	Analysis and Design of Singly and Doubly Reinforced RCC beam using LSM. Or any one activity from below: Solve set of Questions given by the course instructor. Study of IS 456 2000 provisions on Limit state of collapse: Flexure.	02
5 th Week (Tutorial)	Analysis and Design of Flanged beams for Flexure using LSM. Design of RCC beams in shear, bond, and torsion. (Numericals Based on this module will be solved in tutorial class)	02
6 th Week (Assignment)	Analysis and Design of Flanged beams for Flexure using LSM. Or any one activity from below: Design of RCC beams in shear, bond, and torsion. Solve set of Questions given by the course instructor. Study of IS 456 2000 provisions on Limit state of collapse- Shear, Bond and Torsion.	02
7 th Week (Tutorial)	Design of Simply supported One-way and Two-way slabs as per IS: 456-2000 (Numericals Based on this module will be solved in tutorial class)	02
8 th Week (Assignment)	Design of Simply supported One-way and Two-way slabs as per IS: 456-2000. Or any one activity from below: Solve set of Questions given by the course instructor. Study of IS: 456-2000 provisions on Design of RCC slabs.	02
9 th Week (Tutorial)	Analysis and Design of Columns loaded Axially, Uni-axially, and Bi-axially, using LSM. (Numericals Based on this module will be solved in tutorial class)	02
10 th Week (Assignment)	Analysis and Design of Columns loaded Axially, Uni-axially, and Bi-axially, using LSM. or any one activity from below: Solve set of Questions given by the course instructor. Studying the development of interactive curves and their use in column design.	02

	Study of IS: 456-2000 Provisions for Limit State of Collapse – Compression	
11 th Week (Tutorial)	Design of Isolated square and rectangular footings subjected to axial load and moment. (Numericals Based on this module will be solved in tutorial class)	02
12 th Week (Assignment)	Design of Isolated Square and rectangular footings subjected to axial load and moment. or any one activity from below: Solve set of Questions given by the course instructor. Study of IS: 456-2000 provisions related to design of RCC foundations. Report or presentation on Significance and Design of different types of RCC Foundations by various groups of students.	02
13 th Week	Viva – Voce Examination	02

Assessment:

- **Term Work**

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	10 Marks
Assignments	:	10 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Oral Examination**

Oral examination will be based on entire syllabus.

- **Recommended books:**

Design of Reinforced Concrete Structures: Dayaratnam, P; Oxford and IBH.

Limit State Design of Reinforced Concrete: Jain A. K, Nemchand and Bros., Roorkee

Limit State Design of Reinforced Concrete: Shah and Karve, Structure Publications, Pune.

Ultimate Strength Design for Structural Concrete: Arthur, P. D. and Ramakrishnan, V., Wheeler and Co. Pvt. Ltd.

Reinforced Concrete: H.J. Shah, Charotar Publishers, Anand.

Fundamentals of Reinforced Concrete: Sinha & Roy, S. Chand and Co. Ltd.

Illustrated Reinforced Concrete Design: Dr. V. L. Shah and Dr. S. R. Karve, Structure Publications, Pune.

Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A, John Wiley (2007), 7th Edition.

Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.

Semester-V

Course Code	Course Name	Credits
CEL502	Applied Hydraulics (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

- 1 To describe the concepts of fluid dynamics and its applications.
- 2 To exemplify the fundamentals of impulse momentum principle and explain the working of various hydraulic machines.
- 3 To classify the uniform and non-uniform flow in open channel.

Course Outcomes:

At the end of the course, learner will be able to:

- 1 Evaluate the efficiencies and discuss the working of various pumps and turbines.
- 2 Apply impulse momentum principle to hydraulic machines.
- 3 Determine the rate of flow through open channel.
- 4 Generate and evaluate Gradually varied flow (GVF) and Rapid varied Flow (RVF) in open channel flow.
- 5 Compute the Chezy's Constant through tilting flume.

List of Experiments (Minimum Six)		
Module	Detailed Content	Lab Session / Hr.
1	Impact of jet, flat plate, inclined plate, curved vanes.	02
2	Performance of Pelton turbine.	02
3	Performance of Francis Turbine.	02
4	Performance of Kaplan Turbine.	02
5	Performance of Centrifugal pumps.	02
6	Chezy's roughness factor.	02
7	Specific energy.	02
8	Hydraulic Jump.	02
9	Calibration of Broad crested weir/Venturi flume.	02

Assessment:

• Term Work

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and assignments. The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise. The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	10 Marks
Assignments	:	10 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

• End Semester Oral Examination

Pair of Internal and External Examiner should conduct oral examination.

Reference Books:

- 1 Fluid Mechanics and Hydraulic Machines: R. K. Rajput, S. Chand and Company.
- 2 Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi.
- 3 Hydraulics Fluid Mechanics and Fluid Machines: S. Ramamrutham, Dhanpat Rai Publishing Company (P) Ltd-New Delhi.
- 4 Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
- 5 Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538.
- 6 Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons.
- 7 Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

Semester-V

Course Code	Course Name	Credits
CEL503	Geotechnical Engineering – I (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

- 1 Determination of moisture content, specific gravity of soil solids and in-situ field density of soils as well as field identification of fine-grained soils
- 2 To determine the grain size distribution of soils and consistency or Atterberg limits of fine-grained soils
- 3 To determine coefficient of permeability of soils in laboratory
- 4 To determine compaction characteristics of soils in laboratory
- 5 To determine the density index (relative density) of cohesionless soil
- 6 To determine field SPT 'N' value by Standard Penetration Test

Course Outcomes:

At the end of the course, learner will be able to:

- 1 Determine the physical and engineering properties of soil
- 2 Determine the plasticity characteristics of soil
- 3 Carry out sieve analysis of soil, plot grain size distribution curve and determine the IS classification of soil
- 4 Determine coefficient of permeability of soils
- 5 Determine the compaction characteristics of soils
- 6 Compute the field SPT 'N' value and prepare the bore log

List of Experiments (Minimum ten)		
Module	Detailed Content	Lab Session / Hr.
1	Determination of natural moisture content of soil using oven drying method Following other methods to find moisture content shall be explained briefly: a) Pycnometer method b) Sand bath method c) Alcohol method d) Torsional balance method e) Moisture meter f) Radio activity method	02
2	Specific gravity of soil grains by density bottle method or Pycnometer method	02
3	Field density using core cutter method	02
4	Field density using sand replacement method	02
5	Field identification of fine-grained soils	02
6	Grain size distribution of coarse-grained portions (gravel and sand) of soil by sieve analysis	02
7	Grain size distribution of fine portions (silt and clay) of the soil by Hydrometer analysis	02
8	Determination of liquid (Casagrande method), plastic and shrinkage limits	02
9	Determination of liquid limit by cone penetrometer method	02
10	Determination of co-efficient of permeability using constant head method	02
11	Determination of co-efficient of permeability using falling head method	02
12	Compaction test, IS light compaction test/ Standard Proctor test	02
13	Compaction test, IS heavy compaction test/ Modified Proctor test	02
14	Relative density (or, density index) test	02
15	Standard penetration test	02

Assessment:

• Term Work

- The term work shall be comprised of the neatly written reports based on the experiments performed in the laboratory, assignments, attendance and case study.
- The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems on each module/ sub-module.
- Students (5 students max. in a group) should perform a case study on Forensic Investigation for Geotechnical Failures/or, Geo environmental Engineering and must submit a report or power

point presentation on the same. The questions related to this concept shall not be asked in the theory examination. However, it shall be treated as a part of term work submission.

Distribution of Term-work Marks

The marks of the term work shall be judiciously awarded depending upon the quality of the laboratory works, assignments, attendance and case study. The final certification acceptance of term work warrants the satisfactory and appropriate completion of laboratory work, assignments and case study with the minimum passing marks by the students. The following weightage of marks shall be given for different components of the term-work.:

Laboratory Work	:	12 Marks
Case study	:	03 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

• End Semester Oral Examination

The oral examination shall be based upon the entire theory and laboratory syllabus.

Reference Books:

- 1 SCI/SCOPUS Indexed Refereed International Journals (For Case Studies)
- 2 Relevant Indian Standard Specifications Codes, BIS Publications, New Delhi.
- 3 Departmental Laboratory Manual
- 4 Standard Geotechnical Engineering Handbook
- 5 NPTEL Video lectures on Practical.

Semester-V

Course Code	Course Name	Credits
CEL504	Transportation Engineering (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objective:

- 1 To determine Penetration grade and Viscosity grade of bitumen.
- 2 To find the Softening point and Ductility value of bitumen.
- 3 To determine Impact, Abrasion and Crushing value of aggregate.
- 4 To carry out shape test on aggregates.
- 5 To carry out Classified volume study and plot speed profile at mid-block section.

Course Outcomes:

At the end of the course, learner will be able to:

- 1 Classify Bitumen on basis of Penetration and Viscosity grade.
- 2 Select Bitumen as per suitability on basis of Softening point and Ductility value.
- 3 Determine suitability of aggregate on basis of Impact value, Abrasion value and Crushing value.
- 4 Differentiate Elongated and Flaky aggregates on basis of Shape test.
- 5 Carry out Classified volume study at mid-block section of road.
- 6 Plot speed profile curve (S-Curve) at mid-block section.

List of Experiments (Minimum Eight)		
Module	Detailed Content	Lab Session / Hr.
1	Penetration Test on Bitumen.	02
2	Viscosity Test on Bitumen.	02
3	Softening Point Test on Bitumen	02
4	Ductility Test on Bitumen	02
5	Determination of Aggregate Impact Value	02
6	Determination of Aggregate Crushing Value	02
7	Determination of Abrasion Value of Road Aggregate	02
8	Shape Test of Aggregate	02
9	Classified Volume count at mid-block section	02
10	Speed profile study at mid-block section	02

Assessment:

• Term Work

Including Laboratory Work Survey project report and Assignments, Distribution of marks for Term Work shall be as follows:

Laboratory Work and Traffic Survey : 10 Marks

Assignments : 10 Marks

Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

• End Semester Oral Examination

Oral exam will be based on experiments performed, traffic survey carried out and theory syllabus.

Reference Books:

- 1 Highway Engineering: Khanna, S.K. and Justo, C. E. G.; Nem Chand and Bros., Roorkee.
- 2 Principles, Practice and Design of Highway Engineering (Including Airport Engineering)" Sharma, S.K.; S. Chand and Company Pvt. Ltd., New Delhi.
- 3 Highway Material and Pavement Testing: Dr. S. K. Khanna, Dr. C. E. G. Justo and Dr. A. Veeraragavan. Nem Chand and Bros., Roorkee, India.
- 4 Traffic Engineering and Transport Planning: Kadiyali, L.R., Khanna Publishers, Delhi
- 5 Principles and Practice of Highway Engineering: Kadiyali, L. R.; Khanna Publishers, Delhi.
- 6 Relevant specifications of MORTH and relevant IRC codes.

Semester-V

Course Code	Course Name	Credits
CEL505	Professional Communication and Ethics-II	02

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
---	02*+02	-	-	02	-	02

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Rationale

This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.

Course Objectives

- 1 Discern and develop an effective style of writing important technical/business documents.
- 2 Investigate possible resources and plan a successful job campaign.
- 3 Understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
- 4 Develop creative and impactful presentation skills.
- 5 Analyze personal traits, interests, values, aptitudes and skills.
- 6 Understand the importance of integrity and develop a personal code of ethics.

Course Outcomes

Learner will be able to

- 1 Plan and prepare effective business/technical documents which will in turn provide solid foundation for their future managerial roles.
- 2 Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
- 3 Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.

- 4 Deliver persuasive and professional presentations.
- 5 Develop creative thinking and interpersonal skills required for effective professional communication.
- 6 Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Advanced Technical Writing: Project/ Problem Based Learning (PBL)		06
	1.1	Purpose and Classification of Reports, Classification on the basis of: Subject Matter (Technology, Accounting, Finance, Marketing, etc.); Time Interval (Periodic, One-time, Special); Function (Informational, Analytical, etc.); Physical Factors (Memorandum, Letter, Short & Long)	
	1.2	Parts of a Long Formal Report Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter)	
	1.3	Language and Style of Reports: Tense, Person & Voice of Reports, Numbering Style of Chapters, Sections, Figures, Tables and Equations, Referencing Styles in APA & MLA Format, Proofreading through Plagiarism Checkers	
	1.4	Definition, Purpose & Types of Proposals: Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals)	
	1.5	Parts of a Proposal Elements: Scope and Limitations, Conclusion	
	1.6	Technical Paper Writing: Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References), Language and Formatting, Referencing in IEEE Format	
2	Employment Skills		06
	2.1	Cover Letter & Resume: Parts and Content of a Cover Letter, Difference between Bio-data, Resume & CV, Essential Parts of a Resume, Types of Resume (Chronological, Functional & Combination)	
	2.2	Statement of Purpose: Importance of SOP, Tips for Writing an Effective SOP	
	2.3	Verbal Aptitude Test: Modelled on CAT, GRE, GMAT exams	
	2.4	Group Discussions: Purpose of a GD, Parameters of Evaluating a GD, Types of GDs (Normal, Case-based & Role Plays), GD Etiquettes	
	2.5	Personal Interviews: Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioral, Problem Solving & Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	

3	Business Meetings		02
	3.1	Conducting Business Meetings: Types of Meetings, Roles and Responsibilities of Chairperson, Secretary and Members, Meeting Etiquette	
	3.2	Documentation: Notice, Agenda, Minutes	
4	Technical/ Business Presentations		02
	4.1	Effective Presentation Strategies: Defining Purpose, Analysing Audience, Location and Event, Gathering, Selecting & Arranging Material, structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation, Platform Skills	
	4.2	Group Presentations: Sharing Responsibility in a Team, Building the contents and visuals together, Transition Phases	
5	Interpersonal Skills		08
	5.1	Interpersonal Skills: Emotional Intelligence, Leadership & Motivation, Conflict Management & Negotiation, Time Management, Assertiveness, Decision Making	
	5.2	Start-up Skills: Financial Literacy, Risk Assessment, Data Analysis (e.g., Consumer Behaviour, Market Trends, etc.)	
6	Corporate Ethics		02
	6.1	Intellectual Property Rights: Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications, Integrated Circuits, Trade Secrets (Undisclosed Information)	
	6.2	Case Studies: Cases related to Business/ Corporate Ethics	
Total			26

List of Assignments for Term Work

In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.

- 1 Cover Letter and Resume
- 2 Short Proposal
- 3 Meeting Documentation
- 4 Writing a Technical Paper/ Analysing a Published Technical Paper
- 5 Writing a SOP
- 6 IPR
- 7 Interpersonal Skills
- 8 Aptitude test (Verbal Ability)

Note:

- The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
- The group size for the final report presentation should not be less than 5 students and not to exceed more than 7 students.
- There will be an end–semester presentation based on the book report.

Assessment:

- **Term Work**

Term work shall consist of minimum 8 experiments.

Assignments	:	10 Marks
Presentation Slides	:	05 Marks
Book Report (Hard Copy)	:	05 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

- **Internal Oral**

Oral Examination will be based on a GD & the Project/Book Report presentation

Group Discussion	:	10 Marks
Individual Presentation	:	10 Marks
Group Dynamics	:	05 Marks

Recommended Books:

- 1 Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/ Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill.
- 2 Bovée, C. L., & Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.
- 3 Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.
- 4 Masters, L. A., Wallace, H. R., & Harwood, L. (2011). Personal development for life and work. Mason: South-Western Cengage Learning.
- 5 Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational behaviour. Harlow, England: Pearson.
- 6 Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
- 7 Archana Ram (2018) Place Mentor, Tests of Aptitude for Placement Readiness. Oxford University Press
- 8 Sanjay Kumar & Pushp Lata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Semester-V

Course Code	Course Name	Credits
CEM501	Mini Project -2A	2

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	04	-	-	2	-	2

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Rationale

From primitive habitats of early years to modern buildings, the civil engineering industry's growth has been needing based and society centric. Civil engineers deal with many challenges on daily basis that most people do not have any idea. Mumbai University proposed Mini projects in the syllabus so that the budding civil engineers can connect with the world outside their books and have the idea of future course. The Mini project should actually provide solution to a typical problem after a brainstorming and in a stipulated period. The competitions ahead will give students the experience of the civil engineering industry's real-world problems and make students brainstorm ideas, learn, and explore the civil engineering industry.

Course Objectives:

- 1 To recognize societal problems and convert them into a problem statement by understanding of facts and ideas in a group activity.
- 2 To deal with new problems and situations by applying acquired knowledge, facts, techniques and rules in a different way.
- 3 To examine and break information into parts, by analyzing motives or causes.
- 4 To learn evaluating information, validity of ideas and work based on a set of criteria.
- 5 To create solutions by compiling information together in a different way.
- 6 To design model by combining elements in a new pattern or proposing new solutions.

Course Outcomes:

At the end of the course, learner will be able to:

- 1 Identify problems based on societal /research needs and formulate a solution strategy.
- 2 Apply fundamentals to develop solutions to solve societal problems in a group
- 3 Analyze the specific need, formulate the problem and deduce the interdisciplinary approaches, software-based solutions and computer applications.
- 4 Develop systematic flow chart, evaluate inter disciplinary practices, devices, available software, estimate and recommend possible solutions.
- 5 Draw the proper inferences from available results through theoretical/ experimental/ simulations and assemble physical systems.
- 6 Create devices or design a computer program or develop computer application.

• Guidelines for Mini Project -2A

Expected outcome is hardware based, “A Working Model.”

Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.

Students should find ‘List of Mini project – 2A problems’ in University web portal www.mu.ac.in, and in consultation with faculty supervisor/ head of department/ internal committee of faculties select the title.

Students shall submit implementation plan in the form of Gant/ PERT/ CPM chart, which will cover weekly activity of mini project.

A log book to be prepared by each group, wherein group can record weekly work progress, guide/ supervisor can verify and record notes/ comments.

Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that Students come out with original solution.

However, based on the individual students or group capability, with the mentor’s recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/ modifications or a completely new project idea in even semester. This policy can be adopted on case-by-case basis.

List of approved problems for Mini Project -2A:	
H501:	Construction of Model showing New application of alternative materials and byproducts of different industries for Durability and sustainability.
H502:	Construction of Model/ device for Smart Traffic Management System Using Internet of Things
H503:	IOT based smart device for traffic signal monitoring system using vehicle Count.
H504:	Mini Project on Construction of Model showing New application of use of Fly Ash in Civil Engineering works.
H505:	Mini Project on specimen of Modified Concrete Pavements (using unconventional, recycled or waste product)
H506:	Novel device for Base isolation system for multistoried building
H507:	Mini project on specimen of light transmitting concrete.
H508:	Model of Novel Seismic isolation devices for bridge structures.
H509:	Novel Applications of Bamboo as a building material specimen.
H510:	Development of device using sensors for deflection of girders. Beams, slabs or bridges.
H511:	Development of device using sensors for detection of fracture in Railway tracks.
H512:	Mini project on specimen of Bubble deck slab.
H513:	Construction of specimen of GFRG panels as walls in buildings instead of conventional walls.
H514:	Construction of specimen of Agro waste reinforced panels as walls in buildings instead of conventional walls.
H515:	Construction of specimen of unconventional panels as walls in buildings instead of conventional walls.
H516:	Construction of specimen of Ferro cement Slab as a replacement to RCC slab.
H517:	Construction of specimen of No Fines Concrete or porous Concrete and its applications.
H518:	Construction of Model of Novel Soil Stability technique to prevent landslides.
H519:	Construction of Model of a dwelling unit (house) in rural area.
H520:	Typical design of Model for construction of toilets in rural India.
H521:	Construction of Model for Typical applications of Ferro concrete.
H522:	Construction of Model of road paths with locally sourced materials in villages.
H523:	Construction of Model showing Typical application of Prestressed concrete.
H524:	Construction of Model showing Typical application of fiber reinforced concrete.

(This is tentative list, this list will be continuously updated by contributions from faculty, industry and alumni.)

Guidelines for Assessment of Mini Project:

• Term Work

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below:

Marks awarded by guide/supervisor based on log book : 10 Marks

Marks awarded by review committee : 10 Marks

Quality of Project report : 5 Marks

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

• One-year project:

Only if a project is very demanding it will be considered for 'One Year Project'. Subject to approval by the Head of the department.

Outcome shall be a 'Hardware and a software based' solution

There shall also a 'technical paper' to be presented in conference/published in journal (UGC approved) or student's competition.

In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.

First shall be for finalization of problem

Second shall be on finalization of proposed solution of problem.

In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.

First review is based on readiness of building working prototype to be conducted.

Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

• Half-year project:

In this case in one semester students' group shall complete project in all aspects including

Identification of need/problem

Proposed final solution

Procurement of components/systems

Building prototype and testing

Two reviews will be conducted for continuous assessment,

First shall be for finalization of problem and proposed solution.

Second shall be for implementation and testing of solution.

- **Assessment criteria of Mini Project:**

Mini Project shall be assessed based on following criteria:

- Quality of survey/ need identification
- Clarity of Problem definition based on need.
- Innovativeness in solutions
- Feasibility of proposed problem solutions and selection of best solution
- Cost effectiveness
- Societal impact
- Innovativeness
- Cost effectiveness and Societal impact
- Full functioning of working model as per stated requirements
- Effective use of skill sets
- Effective use of standard engineering norms
- Contribution of an individual as member or leader
- Clarity in written and oral communication

In one year, project, first semester evaluation may be based on first six criteria and remaining may be used for second semester evaluation of performance of students in mini project.

In case of half year project all criteria in generic may be considered for evaluation of performance of students in mini project.

- **Guidelines for Assessment of Mini Project Practical/Oral Examination:**

Report should be prepared as per the guidelines issued by the University of Mumbai.

Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years and approved by head of Institution.

Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

- **Mini Project shall be assessed based on following points:**

- Quality of problem and Clarity
- Innovativeness in solutions
- Cost effectiveness and Societal impact
- Full functioning of working model as per stated requirements
- Effective use of skill sets
- Effective use of standard engineering norms
- Contribution of an individuals as member or leader
- Clarity in written and oral communication

Semester VI

Semester-VI

Course Code	Course Name	Credits
CEC601	Design and Drawing of Steel Structures	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	4 Hours	-	-	-	100

Rationale

Steel structures are preferred due to their higher strength, speed of construction and aesthetic view. Civil Engineers must have knowledge of designing and detailing of steel structures to make structures safe and serviceable during its life span. I.S. code specifying the use of Limit State design philosophy for design of steel structures and its various components. This course is designed to provide basic knowledge of design and detailing of steel structures.

Objectives

- 1 To make students familiar with behavior of steel structure and their components under the action of various loads.
- 2 To train the students for effective use of IS codes, design tables and aids in analyzing and designing the steel structures by limit state method.
- 3 To help students design connections of steel members.
- 4 To equip students with aspects required for designing tension member, compression members and column bases.
- 5 To equip students with aspects required for designing of flexural members.
- 6 To aid students in designing steel trusses.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Introduction		03
	1.1	Types of steel structures, Properties of Structural Steel, Indian Standard Specifications and Sections, Advantages and limitations of WSM, permissible stresses in WSM. Introduction to Limit State Design, partial safety factors for load and resistance, design load combinations, section classification such as plastic, compact, semi-compact and slender.	
2	Design of Bolted And Welded Connections		06
	2.1	Design of bolted and welded connections for axial force, beam to beam and beam to column connections. Framed, stiffened and unstiffened seat connections, bracket connections.	
3	Design of Tension Members		04
	3.1	Introduction, types of tension members, net area calculation.	
	3.2	Design strength due to yielding, rupture and block shear.	
	3.3	Design of tension members with welded and bolted end connection using single angle section & double angle section.	
4	Design of Compression Members and Column Bases		11
	4.1	Introduction, types of compression members, classification of cross sections, types of buckling, effective length of column and slenderness ratio, buckling curves, design of compression members as struts using single angle sections & double angle section.	
	4.2	Design of axially loaded column using rolled steel sections, design of built-up column, laced and battened Columns.	
	4.3	Design of slab bases & gusseted base.	
5	Design of Flexural Members		11
	5.1	Design strength in bending, effective length, Lateral torsion buckling behavior of unrestrained beams, design of single rolled section with or without flange plates, design strength of laterally supported beams, low and high shear, design strength of laterally unsupported beams, web buckling, web crippling, shear lag effect and deflection.	
	5.2	Design of welded plate girder: proportioning of web and flanges, flange plate curtailment	
6	Design of Truss		04
	6.1	Design of determinate truss. Calculation of dead load, live load and wind load acting on truss. Load combinations and calculation of internal forces. Design and detailing of members. Support detailing. Design of angle section purlin.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Use the knowledge of Limit State Design philosophy as applied to steel structures. IS 800 code clauses
- 2 Design bolted and welded connections.
- 3 Design members subjected to axial tension.
- 4 Design compression members, Built-up columns and column bases.
- 5 Design members subjected to bending moment, shear force etc.
- 6 Estimate design loads as per IS 875 for roof truss and design the Steel roof truss.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total Five questions. $\{(32 + (4 \times 16))\}$
- 2 Question 1 will be compulsory carrying 32 marks and should be based on steel design project.
- 3 Remaining questions will be carrying 4×16 marks, mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. Only three questions carrying 16 marks need to be solved.
- 4 Total Four questions need to be solved. $(32+16+16+16)$
- 5 In end semester examination, students will write answers in answer booklet and draw sketches on half imperial drawing sheet.
- 6 **Use of relevant IS codes shall be allowed in the examination**

Recommended Books:

- 1 Design of Steel Structure by N. Subramanian, Oxford University Press, New Delhi.
- 2 Limit state design of steel structures by S. K. Duggal, McGraw Hill Education (India) Pvt. Limited, New Delhi.
- 3 Design of steel structure by Limit State Method as per IS: 800- 2007 by Bhavikatti S. S., I.K. International Publishing House, New Delhi.
- 4 Design of Steel Structures by K. S. Sai Ram, Pearson Education, New Delhi.
- 5 Limit state design of steel structures as per IS 800/2007. by S. Kanthimathinathan. I.K. International Publishing House, New Delhi.
- 6 Relevant Indian Specifications, Bureau of Indian Standards, New Delhi
- 7 Limit state design of steel structure by Dr. V.L. Shah and Gore, Structure publication Pvt. Pune.

Reference Books:

- 1 Design of Steel Structure by Allen Williams
- 2 Practical Design of Steel Structure by Karuna Moy Ghosh, Whittles Publishing
- 3 Structural design and drawing by D. Krishnamurthy, CBS Publishers, New Delhi.
- 4 Teaching Resources Material for steel structures by INSDAG Kolkata.

Semester-VI

Course Code	Course Name	Credits
CEC602	Water Resources Engineering	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

India is an agricultural country where majority of population lives in villages so agricultural industry is the backbone of Indian economy. Being a tropical country with large temporal and spatial variation of rainfall and availability of rainfall only for three to four months, irrigation is strongly needed in India. To satisfy this need, enhancing the irrigation facilities in the country is required. This course provides necessary knowledge and information about various irrigation methods as well as water requirements of crops, hydrologic processes, control level fixation of dams and reservoirs and hydraulics of wells. In addition to this, it provides necessary knowledge about analysis and design of gravity dams and earthen dams, different silt theories related to irrigation channels, detailed classification of canal head-works and its distribution system and finally discusses about different canal structures and cross drainage works.

Objectives

- 1 To study different irrigation engineering methods and water requirement of crops.
- 2 To study hydrological cycle, its elements and plotting of hydrographs.
- 3 To study and calculate discharge from aquifers.
- 4 To study control level fixation for reservoir, Dams i.e., gravity dam, its various components and analysis and suitable conditions of earthen dam and its seepage analysis.
- 5 To study importance of silt theories and its design considerations.
- 6 To study Canal headwork, its distribution system and design of canal structures.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Irrigation Methods and Water Requirement of Crops		07
	1.1	National water policy. Introduction to irrigation and need of irrigation, Benefits of irrigation and ill effects of irrigation, types of Irrigation Projects: minor, medium and major irrigation projects and National water policy.	
	1.2	Methods of Irrigation Systems: Surface irrigation and different techniques of water distribution for surface irrigation, Subsurface irrigation, sprinkler irrigation and drip irrigation.	
	1.3	Water Requirement of Crops: Crops and crop seasons in India, delta and duty of crops, relationship between delta and duty of crops. Soil water relationship and its significance from irrigation considerations, root zone soil water, infiltration, consumptive use, frequency of irrigation.	
2	Hydrology		07
	2.1	Hydrologic cycle, Precipitation: Forms and Types of precipitations.	
	2.2	Measurement of rainfall by rain gauges and stream flow measurement. calculation of missing rainfall data and adequacy of rain gauge stations.	
	2.3	Runoff: Runoff- factors affecting runoff, computation of runoff, yield of the catchment runoff hydrograph, flood discharge and its calculations.	
	2.4	Hydrograph: Flood hydrograph- Its components and base-flow separation, Unit hydrograph, application of unit hydrograph, methods of deriving unit hydrograph, S-hydrograph and its application.	
3	Ground Water and Well Hydraulics		05
	3.1	Ground water resources and occurrence of ground water.	
	3.2	Well hydraulics: steady state flow conditions in wells.	
	3.3	Equilibrium equations for confined and unconfined aquifer.	
	3.4	Aquifer tests.	
	3.5	Difference between open well and tube well, Well Losses	
4	Dams and Spillways		09
	4.1	Reservoir, various zones of storage reservoir, control level fixation for a reservoir. Introduction to reservoir sedimentation and control measures.	
	4.2	Gravity Dams: Definition, typical cross section and components of gravity dam, forces acting on gravity dam, modes of failure	

		of gravity dam, structural stability analysis of gravity dam, elementary and practical profile of gravity dam, low and high gravity dam, galleries in gravity dam – Function of gallery and different cross-sections of gallery adopted in practice, joints in gravity dam. control of cracking in concrete dams.	
	4.3	Earthen Dam: Types of earthen dams and methods of construction of earthen dam, causes and failures of earthen dams, seepage line/phreatic line for different conditions and its location using graphical method, seepage control through embankment and through foundations.	
	4.4	Spillways: Introduction, types of spillways – its working and functionality.	
5	Irrigation Channels (Silt Theories)		06
	5.1	Kennedy's theory and method of channel designs silt supporting capacity according to Kennedy's theory.	
	5.2	Lacey's regime theory and application of Lacey's theory for designing channel cross-section.	
	5.3	Comparison between Kennedy's theory and Lacey's theory.	
	5.4	Drawbacks of Kennedy's theory and Lacey's theory.	
	5.5	Introduction to sediment transport in channels.	
6	Canal Headwork-Distribution System and Canal Structures		05
	6.1	Canal Headwork and Distribution System: Classification of canals, canal alignment, canal losses, canal lining, water logging and remedial measures for water logging.	
	6.2	Canal Structures Canal Falls and types of canal falls, canal escapes and types of canal escapes, canal regulators and types of canal regulators, canal outlets and types of canal outlets, cross drainage works and types of cross drainage work.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Describe National water Policy, Calculate Crop water requirement and Classify various types and methods of irrigation.
- 2 Estimate flood discharge and Runoff by traditional and modern usage tools for planning and management of water resources projects.
- 3 Apply knowledge on ground water, well hydraulics to estimate the safe yield and ground water potential
- 4 Analyze and design gravity dams and earthen dams with spillways for sustainable development
- 5 Compare different silt theories related to irrigation channel and design the same.
- 6 Classify and Explain various canal structures and suggest remedial measures for water logging to save fertile irrigation

Internal Assessment**20 Marks**

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination**80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only four questions need to be solved in total.

Recommended Books:

- 1 Irrigation and Water Power Engineering: B.C. Punmia, Pande B.B. Lal, A.K Jain. Laxmi Publications Pvt, Ltd. New Delhi.
- 2 Irrigation Engineering and Hydraulic Structures: S.K. Ukarande, Ane Books Pvt. Ltd. ISBN-9789383656899.
- 3 Irrigation Water Resources and Water Power Engineering: P.N. Modi, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
- 4 Irrigation Engineering and Hydraulic Structures: S. K. Garg, Khanna Publishers. Delhi.
- 5 Design of Irrigation Structures: S. K. Sharma, S. Chand and Co.
- 6 Theory and Design of Irrigation Structures: R. S. Varshney and R. C. Gupta, Nem Chand
- 7 Engineering for Dams, Vol. I to III: Crager, Justin and Hinds, John Wiley
- 8 Design of Small Dams: USBR.
- 9 Hydro Power Structures: R. S. Varshney, Nem Chand and Bross.
- 10 Concrete Dams: R. S. Varshney, Oxford and IBH Publishing Co.

Semester VI

Course Code	Course Name	Credits
CEC603	Geotechnical Engineering-II	3

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
3	--	--	3	--	--	3

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hrs.	--	--	--	100

Rationale

Basic knowledge of analysis and design of foundations is very important for all civil engineers, more so for geotechnical and structural engineers. Soil testing (both field and lab tests) and its analysis are not only compulsory prerequisites for the analysis, design and construction of any major structure but also holds lucrative consultancy work and job opportunities in the field of civil engineering. Immense research opportunities are also available in this field.

Objectives

- 1 Students will gain knowledge of consolidation theory.
- 2 Students will evaluate the shear strength characteristics of the soil. Moreover, they would apply the knowledge for solving the related problems.
- 3 Students will analyze stability of slopes.
- 4 Students will analyze and evaluate lateral earth pressure.
- 5 Students will analyze and design shallow foundation.
- 6 Students will analyze and design deep foundation.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Module Name- Consolidation of soils		06
	1.1	Compressibility & settlement, comparison between compaction & consolidation, concept of excess pore water pressure, initial, primary secondary consolidation, spring analogy for primary consolidation, consolidation test results, coefficient of compressibility, coefficient of volume change, compression, expansion, recompression indices, normally and over consolidated soils.	
	1.2	Terzhaghi's theory of consolidation (no proof)- assumptions, coefficient of vertical consolidation, distribution of hydrostatic excess pore water pressure with depth & time, time factor, relationship between time factor and degree of consolidation, determination of coefficient of vertical consolidation, pre-consolidation pressure.	
	1.3	Final settlements of a soil deposit in the field, time settlement curve, field consolidation curve.	
2	Module Name- Shear strength		05
	2.1	Introduction, frictional cohesive strength, state of stresses in soil mass, principal stresses, determination of stresses on an inclined plane by using analytical and Mohr's circle method, important characteristics of Mohr's circle.	
	2.2	Coulomb theory, Mohr-Coulomb theory- shear strength parameters; Mohr-Coulomb failure envelope- relation between major and minor principal stresses, total & effective stress analysis.	
	2.3	Different types of drainage conditions UU, CU and CD: Direct shear test, Triaxial compression test, Unconfined compression test, Vane shear test; comparison between direct & triaxial tests, interpretation of test results of direct shear & triaxial shear tests stress-strain curves.	
	2.4	Determination of shear strength of soil- pull out test and Introduction to liquefaction of Soils.	
3	Module Name- Stability of Slopes		06
	3.1	Introduction: Types of slopes, types of slope failures, factors of safety.	
	3.2	Stability analysis of infinite slopes in i) cohesionless soil and ii) cohesive soil under a) dry condition, b) submerged condition and c) steady seepage condition along the slope.	

	3.3	Stability analysis of finite slopes: i) Taylor's stability number ii) friction circle method iii) Swedish circle.	
4	Module Name - Lateral Earth Pressure Theories		08
	4.1	Introduction to Lateral Earth Pressure Theories: Concept of lateral earth pressure based on vertical and horizontal stresses, different types of lateral earth pressure	
	4.2	Rankine's earth pressure theory: i) assumptions, ii) active and passive states in cohesionless soil: effect of submergence, effect of uniform surcharge, effect of inclined surcharge iii) active and passive states in cohesive soil	
	4.3	Coulomb's wedge theory: i) assumptions, ii) active and passive states in cohesionless soil, iii) active and passive states in cohesive soil	
	4.4	Rehbann's Graphical Method (no proof)	
	4.5	Culmann's Graphical Method (no proof)	
5	Module Name- Shallow Foundations		08
	5.1	Introduction: types of shallow foundations, definitions of different bearing Capacities	
	5.2	Theoretical methods of determining bearing capacity of shallow foundations: i) Terzaghi's theory: assumptions, zones of failure, modes of failure, ultimate bearing capacity equations for general and local shear failure, factors influencing bearing capacity: shape of footing and water table, limitations of Terzaghi's theory ii) Vesic's theory: bearing capacity equation I.S. Code Method: bearing capacity equation	
	5.3	Field methods of determining bearing capacity of shallow foundations: i) standard penetration test and ii) plate load test	
6	Module Name- Pile Foundations		06
	6.1	Introduction to pile foundations: necessity of pile foundations, types of pile foundation.	
	6.2	Theoretical methods of determining load carrying capacity of pile foundations: i) static formulae and ii) dynamic formulae	
	6.3	Field method of determining load carrying capacity of pile foundations: pile load test	
	6.4	Group action of piles, settlement of pile groups, negative skin friction	
Total Hours			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Evaluate the consolidation parameters for the soil.
- 2 Calculate the shear strength parameters for the soil.
- 3 Calculate the factors of safety of different types of slopes under various soil condition, analyze the stability of slopes.
- 4 Calculate lateral earth pressure under various soil condition.
- 5 Calculate bearing capacity of shallow foundations using theoretical and field methods.
- 6 Calculate load carrying capacity of individual as well as group of pile foundation using theoretical and field methods and pile settlement.

Internal Assessment (20 Marks):

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Average of the two will be considered as IA marks.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total **six questions, each carrying 20 marks.**
- 2 **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
- 3 **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only **Four questions need to be solved.**

Recommended Books:

- 1 Soil Mechanics and Foundation: Dr. B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain; Laxmi Publications
- 2 Soil Mechanics and Foundation Engineering: K.R. Arora; Standard publishers and Distributors
- 3 Soil Mechanics and Foundation Engineering: V.N.S Murthy; Saitech Publications
- 4 Geotechnical Engineering: C. Venkatramaiah; New age International
- 5 Theoretical Soil Mechanic: K. Terzaghi; John Wiley and Sons
- 6 Fundamentals of Soil Engineering: D. W. Taylor; John Wiley and sons
- 7 Relevant Indian Standard Specification Code: BIS Publications, New Delhi
- 8 Soil Mechanics in Theory and Practice: Alam Singh; Asia Publishing House
- 9 Geotechnical Engineering: Purushothama Raj; Tata McGraw Hill Publications
- 10 Basic and Applied Soil Mechanic: Gopal Ranjan and A.S. Rao; New Age International

Semester-VI

Course Code	Course Name	Credits
CEC604	Environmental Engineering	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
04	-	-	04	-	-	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Every civil engineer must be acquainted with the principles of public health engineering, purification of water, sewage collection, design of water and sewage treatment and develop rational approaches towards sustainable waste management via appropriate treatment and reuse. The course deals with the overall features and study of treatment of water, building drainage, rain water harvesting, sewage treatment processes and solid waste management. The course also lays emphasis on the knowledge of Air and Noise pollution.

Objectives

- 1 To demonstrate the necessary knowledge and concepts in the fields of water supply and quality of water.
- 2 To impart necessary skill for the design and operation of various units of water treatment facilities.
- 3 To recognize the necessary knowledge of good plumbing system, building drainage and rainwater harvesting.
- 4 To demonstrate the necessary knowledge on domestic sewage and Sewerage system.
- 5 To develop a flow Content for sewage treatment and design its units.
- 6 To impart the basic understanding of Air pollution, noise pollution and solid waste so as to control its adversity on ambient environment.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Water Supply and Quality Of Water		04
	1.1	Water supply: Water supply systems, water resources, types of intake structures, distribution systems of water and distribution layouts.	
	1.2	Quality of water: Introduction to pure water: potable, wholesome, palatable, distilled, polluted and contaminated water, drinking water standards and characteristics of water, water borne diseases.	
2	Water Treatment		15
	2.1	WTP: Typical layout of WTP, Aeration, Types of Aeration systems, sedimentation, types of settling, tube settlers, design of sedimentation tank.	
	2.2	Coagulation and flocculation: Principle of coagulation, flocculation, Clari flocculator, coagulants aids.	
	2.3	Filtration: rapid sand filters, operation, cleaning and back-washing, Entire design of rapid gravity filter with under drainage system. Pressure filter: Construction and operation	
	2.4	Disinfection: Different methods of disinfection, chlorination and chemistry of chlorination, chlorine demand, free and combined chlorine, various forms of chlorine, types of chlorination. Numerical to calculate quantity of required chlorine doses.	
	2.5	Advanced and Miscellaneous Treatments: Water softening by lime soda process and by base exchange method, Reverse Osmosis, Activated carbon, Membrane filtration, Removal of Iron and Manganese.	
3	Building Water Supply, Drainage and Rainwater Harvesting		04
	3.1	Building water supply: Water demands, Per capita Supply, Service connection from main, Water meter.	
	3.2	Building drainage: basic principles, traps-types, location and function, Systems of Plumbing, anti siphonic and vent pipes.	
	3.3	Rainwater harvesting: Need for rainwater harvesting, Annual potential, Roof-top rain water harvesting. Numerical on annual rainwater harvesting potential.	

4	Domestic Sewage and Sewerage System:		08
	4.1	Sewage: Introduction to domestic sewage, and storm water, System of sanitation, Physical and chemical characteristics, decomposition of sewage, BOD, COD, numerical on BOD. MPCB norms for disposal of sewage effluent.	
	4.2	Sewerage system: Systems of sewerage and their layouts: Separate, Combined and partially combined system, merits and demerits, self-cleaning velocity and non-scouring velocity, Sewer- Shape, hydraulic design of sewers, Laying and testing of sewers, manhole-location, necessity, types and drop manhole, ventilation	
5	Sewage Treatment		15
	5.1	Treatment processes: Objective, methods of treatment, flow sheets showing Preliminary, Primary, Secondary and Tertiary treatment. Primary treatment: Screening, Grit removal, Oil and Grease removal, settling tank.	
		Secondary Treatment Methods: Trickling filter- Principle, Process description and Design of trickling filter. Activated sludge process (ASP) - Principle, Process description, Recirculation of sludge, (numerical), Sludge volume index.	
	5.2	Introduction to Biological Treatment: Aerated lagoons, Oxidation ponds, oxidation ditches.	
		Self-purification of natural waterbodies: Oxygen economy, Disposal of treated effluent. Disposal of Raw and treated sewage on land and water, DO sag curve.	
	5.3	Rural and Low-cost sanitation: Septic Tank and Soak Pit – Operation, suitability and Design	
6	Air Pollution, Noise Pollution and Municipal Solid Waste Management		06
	6.1	Air pollution: Composition of air, Quantification of air pollutants, Air quality standards, Effect of air pollution on Environment, Introduction to Air pollution control devices.	
	6.2	Noise pollution: Basic concept and measurement, Effects of noise, and control methods, and numerical on sound level.	
	6.3	Municipal Solid Waste Management: Sources, storage, treatment, disposal, 5R Principles.	
Total			52

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Analyse the quality of water and make outline of water Supply scheme.
- 2 Design the various units of water treatment plant and apply the advanced, miscellaneous treatments whenever necessary.
- 3 Build service connection of water supply from main and building drainage system at construction site along with rain water harvesting layout.
- 4 Analyse and plan sewerage system along with test for sewer line.
- 5 Design the units of sewage treatment plant. Also, able to apply the knowledge of low-cost treatment and stream sanitation.
- 6 Understand air pollution, noise pollution and functional elements of solid waste management.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Site Visit:

The students will visit to sewage treatment plant/ water treatment plant in the nearby vicinity or in the city and prepare detailed report thereof. This report will form a part of the term work

Recommended Books:

- 1 Water Supply Engineering: S. K. Garg, Khanna Publication.
- 2 Water Supply Engineering: P.N. Modi, Rajsons Publication.
- 3 Water Supply and Sanitary Engineering: S.K. Hussain, Oxford & IBH Publication, New Delhi
- 4 Environmental Engineering: B. C. Punmia, Laxmi Publications, New Delhi.
- 5 Solid waste management in developing countries: A.D. Bhide and B.B. Sundaresan
- 6 Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: S. K. Garg, Khanna Publishers New Delhi
- 7 Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian
- 8 Integrated solid waste management, Tchobanoglous. Theissen and Vigil, McGraw Hill Publication.

Reference Books:

- 1 Manual on Wastewater Treatment 3rd Ed. Pub: CPH and Env. Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1991.
- 2 Plumbing Engineering, Theory and Practice: *Patil S. M.*, Seema Publication, Mumbai.
- 3 Manual on Municipal Solid Waste Management: Ministry of urban development, New Delhi.
- 4 Water Supply and Sewerage:*E. W. Steel.*
- 5 Manual on Water Supply and Treatment, (latest Ed.): Ministry of Urban Development, New Delhi.
- 6 Water supply and pollution control: J.W. Clark, W. Veisman, M.J. Hammer, International textbook company.
- 7 CPHEEO Manual on Water Supply and Treatment.
- 8 CPHEEO Manual on Sewage and Treatment.
- 9 Environmental Engineering: Peavy, H.S., Rowe D.R., Tchobanoglous G.; 1991, Tata-Mcgraw Hill.

Semester-VI

Course Code	Course Name	Credits
CEDLO6011	Department Level Optional Course -2 Rock Mechanics	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

The Civil Engineering structures are built on or through rocks. The design of structures depends on the rock mass properties and the interaction between the rock and the structure. This demands the study of deformation resulting from the strain of rocks in response to various stresses working on them. The mechanisms and character of the deformation of rocks can be investigated through laboratory experiments. The course will give an idea of in- situ testing of the rock and observation of geological conditions that can affect the way a rock behaves when subjected to loads and stresses.

Objectives

- 1 To provide basic knowledge of Rock -Mechanics to understand design aspects of various structures on or through rocks.
- 2 To study the various classification schemes of rock masses and their application.
- 3 To study the physical properties of rocks and various lab test conducted on them to determine the strength.
- 4 To determine properties and behavior of various types of rock under different loading conditions.
- 5 To study bearing capacity, stress distribution and factor of safety within the rock.
- 6 To study the stability of rock slopes and design aspects of openings in/on the rocks.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Structural Geology and Data Interpretation		05
	1.1	Introduction to Rock Mechanics and Importance	
	1.2	Geological classification of rocks	
	1.3	Description of discontinuities and their effect on rocks	
	1.4	Stereographic Analysis of structural Geology	
2	Engineering Classification of Rocks and Rock Masses:		06
	2.1	Classification of intact rocks. Rock mass classifications: Rock Quality Designation (RQD), Rock Structural Rating (RSR), Rock Mass Quality (Q system).	
	2.2	Strength and Modulus from classifications, classification based on Strength and Modulus.	
	2.3	Geo-mechanics (RMR)} and Geo-engineering classification	
	2.4	Deere and Miller's Engineering Classification	
3	Laboratory Testing of Rocks: Field and Laboratory Tests on Rocks		07
	3.1	Determination of physical properties of rocks	
	3.2	Uniaxial Compressive Strength Test	
	3.3	Tensile Strength Test	
	3.4	Direct Shear Test and Triaxial Test	
	3.5	Slake Durability Test	
	3.6	Schmidt Rebound Hardness, Swelling Pressure and Free-Swell, Void Index, Hydraulic fracture, Flat Jack Test	
4	Strength, Modulus and Stress-Strain Responses of Rocks:		07
	4.1	Factors influencing rock responses, Strength criteria for isotropic intact rocks, Modulus of isotropic intact rocks.	
	4.2	Uni-axial Compressive Strength of intact anisotropic rocks, Strength due to induced anisotropy in rocks, Compressive Strength and Modulus from SPT.	
	4.3	Stress- strain models (constitutive models, elastic stress-strain model, elastic-plastic stress-strain model, Visco-elastic Model.	
5	Bearing Capacity of Rocks:		06
	5.1	Estimation of bearing capacity (foundation on intact rock, heavily fractured rock), UBC with Hoek-Brown criterion, foundation on slope	
	5.2	Stress distribution in rocks, Factor of safety, strengthening measures (concrete shear keys, bored concrete piles, tensioned	

		cable anchors, concrete block at toe),	
	5.3	Settlement in rocks (from joint factor, for horizontal joints, from field tests).	
6	Stability of Rock Slopes & Opening in Rocks		08
	6.1	Modes of failure, rotational failure, plane failure, wedge method of analysis, buckling failure, toppling failure, application of stereographic projection, Remedial measures.	
	6.2	Rock Bolting and Grouting: Methods to improve rock mass responses, grouting in rocks, objectives, contact grouting, consolidation grouting, process of grouting, grout requirement, types of grout, stage grouting, grout curtain. Rock Bolting Rock anchors.	
	6.3	Tunneling: Ground conditions in tunneling, Computing structural discontinuities in rock masses, requirement of lining in tunnels, pressure tunnels and tunnels for other purposes, application of stereographic projection.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Explain basic concepts of Rock -Mechanics and apply it to design aspects of various Civil Engineering structures on or through the rocks.
- 2 Classify the rock masses and evaluate them for various Civil Engineering works.
- 3 Explain the laboratory testing of rocks and determine the physical properties and strength of intact rocks and rock masses.
- 4 Explain the stress-strain responses of the rocks and influencing factors.
- 5 Determine the bearing capacity and factor of safety of rocks.
- 6 Determine the stability of slopes and underground excavations.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Introduction to Rock Mechanics: Goodman, RE (1989), Canada, Jhon Wiley & Sons.
- 2 Rock Slope Engineering, Hoek, E and Bray, JW (1977), The Institution of Mining and Metallurgy, London.
- 3 Rock Mechanics and Design of Structures on Rock: *Obert, Leon and W. I. Duvall*.
- 4 Engineering Rock Mass Classification, Singh, B and Goel RK (2001), Oxford, UK, Elsevier Inc.

Reference Books:

- 1 Rock Mechanics in Engineering Practice: *K. G. Stagg and O. C. Zienkiewicz*, John Willey and Sons, New York.
- 2 Rock Mechanics – Vol. I and II: *Jumukis*, Trans Tech Publication, USA.
- 3 Fundamentals of Rock Mechanics: Jaeger, JG, Cook, NGW and Zimmerman, RW (2007) 4 th Ed., Singapore, Blackwell Publishing
- 4 Rock Mechanics and Design of Structures on Rock: *Obert, Leon and W. I. Duvall*.

Semester-VI

Course Code	Course Name	Credits
CEDLO6012	Department Level Optional Course - 1 Biological Process and Contamination Removal	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Biological treatment processes are widely used in both developed and developing countries to control and accelerate the natural process of organic matter decomposition. The process is often used to treat biodegradable waste materials released from domestic, commercial and industrial sources before they are disposed of. However, it is also observed to further treat the wastewater for contamination removal in order to remove and treat toxic materials. The course deals with the overall features and study of biological treatments of wastewater and contamination removal. The course lays emphasis on complete updates of these processes and knowledge related to design of treatment units.

Objectives

- 1 To understand quality, quantity, characteristics and treatment process of wastewater generated from various sources
- 2 To understand the biological process and treatment of wastewater.
- 3 To provide students the necessary knowledge and concepts of advancements/ emerging techniques of Microbial Growth Kinetics, Utilization of soluble substrate and biotechnological remedies
- 4 To study and design the aerobic decomposition and its application in Aerobic Suspended Growth Biological Treatment Systems.
- 5 To study and design the anerobic decomposition and its application in wastewater treatment.
- 6 To develop rational approaches towards natural and biotechnological methods for contamination removal.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Waste Water Generation, Collection and Conveyance		08
	1.1	Introduction: Domestic waste water, Industrial Wastewater and Stormwater, Conservancy and Water carriage system, Systems of sewerage, Quantity and Quality of Wastewater.	
	1.2	Need for Analysis, Characteristics of wastewater: Analysis of wastewater, Characteristics of wastewater and sampling, Composition, Biochemical characteristics, aerobic decomposition, anaerobic decomposition,	
	1.3	Waste Water Treatment and Flow diagram: Treatment processes: Objective, methods of treatment, flow sheets showing Preliminary, Primary, Secondary and Tertiary treatment. Waste Water Treatment Plant and Effluent Treatment Plants. Various combinations and options. Low-cost treatment plant.	
2	Introduction to Biological Treatment:		03
	2.1	Overview of biological wastewater treatment, objectives of the treatment, role of microorganisms, types of biological processes for wastewater treatment, suspended and attached growth systems.	
3	Microbial Growth Kinetics		06
	3.1	Microbial Growth Kinetics terminology, rate of utilization of soluble substrates, rate of biomass growth with soluble substrate, rate of oxygen uptake, effects of temperature, total volatile suspended solids and active biomass, net biomass yield and observed yield.	
	3.2	Biotechnological remedies - Bio-fertilizers, Physical, chemical and Microbiological factors of composting, Health risk – Pathogens, Odor management, Microbial cell/enzyme technology, Adapted microorganisms, Biological removal of Nutrients.	
4	Aerobic Decomposition:		08
	4.1	Aerobic Suspended Growth Biological Treatment Systems: Aerobic biological oxidation, process description, environmental factors, Modifications of ASP: Complete Mix activated sludge, Extended Aeration system, Oxidation Ditch systems, Oxygen activated sludge, Oxidation ponds, Stabilization ponds, Aerobic attached Growth Biological Treatment-Trickling Filter.	
	4.2	Design of ASP, Trickling Filter, Oxidation Pond, Oxidation Ditch and Aerated lagoons.	

5	Anaerobic Decomposition:		08
	5.1	Anaerobic Decomposition: Mechanism of anaerobic fermentation – a multistep process, Microbiology and Biochemistry of Anaerobic processes, Substrate inhibition, Stuck reactors, Standard rate, High rate and Multistage anoxic digesters. Introduction to UASB.	
	5.2	Design of anaerobic treatment units: Anaerobic Lagoons	
6	Natural and Biotechnological Methods of Contamination Removal:		06
	6.1	Natural Treatment Systems: Development of natural treatment systems, Rapid infiltration systems, Overland Flow systems, constructed wetlands, Floating aquatic plant treatment systems. Introduction to engineering Fundamentals of Biotechnology. Heavy Metal Removal using advance treatment methods – Membrane filtration, Reverse Osmosis and Ion exchange.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Determine and analyze the characteristics of wastewater and decide the treatment for wastewater.
- 2 Understand biological treatment process and necessity of contamination removal
- 3 Understand and apply the concepts of advancements/emerging techniques of Microbial Growth Kinetics, Utilization of soluble substrate and biotechnological remedies.
- 4 Summarize the concept of aerobic decomposition and its application in Aerobic Suspended Growth Biological Treatment Systems
- 5 Summarize the concept of the anaerobic decomposition and its application in wastewater treatment.
- 6 To derive the knowledge and develop rational approaches towards natural and biotechnological Methods for contamination removal

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

- 1 Wastewater Engineering Treatment, Disposal, Refuse: Metcalf and Eddy, T.M.H. Edition, New Delhi, 1995.
- 2 Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: S. K. Garg, Khanna Publishers New Delhi.
- 3 Water supply and sanitary Engineering: Hussain S. K., Oxford and IBH Publication, New Delhi.
- 4 Wastewater Treatment for Pollution Control and Reuse by Soli. J Arceivala (Author), Shyam. R Asolekar.
- 5 Environmental Engineering: B. C. Punmia, Laxmi Publications, New Delhi.
- 6 Water Supply and Sewerage: E.W. Steel.
- 7 Introduction to Environmental Engineering, Vesilind, PWS Publishing Company 2000.
- 8 Introduction to Environmental Engineering: P. Aarne Vesilind, Susan M. Morgan, Thompson.
- 9 Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian.
- 10 Basic Principles of Wastewater Treatment Book by Marcos Von Sperling.

Reference Books:

- 1 Manual on Wastewater Treatment 3rd Ed. Pub: CPH and Env. Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1991.
- 2 CPHEEO Manual on Sewage and Treatment.
- 3 Relevant Indian standard specifications and BIS publications.
- 4 Handbook of Water and Wastewater Treatment Plant Operations Book by Frank R. Spellman

Semester-VI

Course Code	Course Name	Credits
CEDLO6013	Department Level Optional Course-2 Construction Equipment & Techniques	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Machines have revolutionized every sphere of human being's life. Engineering constructions also have seen a drastic reformation due to introduction of various construction equipment and techniques. This course provides an extensive overview of advanced equipment used in construction industry and also discusses certain methods/techniques used to construct facilities using these equipments. It makes the student aware of the equipment/techniques required while constructing different kinds of civil engineering structures. Student will be introduced to some emerging technologies in the field of Civil engineering which will make them more industry ready.

Objectives

- 1 To understand the characteristics and complexities involved in large civil engineering projects so that the equipment/technique requirements of a project can be listed out.
- 2 To know the various conventional techniques/equipments used in civil engineering projects.
- 3 To get acquainted with the modern equipments/techniques which have replaced the conventional ones.
- 4 To select the appropriate equipment/techniques in construction for large and heavy engineering projects on the basis of suitability, availability, productivity, output, initial and operation cost, savings in time and other resources, etc.
- 5 To understand the characteristics and complexities involved in large civil engineering projects so that the equipment/technique requirements of a project can be listed out.
- 6 To know the various conventional techniques/equipments used in civil engineering projects.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Introduction		06
	1.1	Equipment v/s Labour, Standard and Special equipments, Types of costs related to equipments including related numerical, Equipment life and Replacement decisions including related numerical, Cycle time, Balancing of equipments and related numerical.	
	1.2	Different categories of construction equipments used conventionally with reference to available types and their output, working mechanism, factors affecting their performance and criteria for selecting a particular equipment: Earthmoving and other hauling equipment, Pavers for road construction. Numbering and Record maintaining of Earthmoving and other hauling equipment's; Pile driving equipment; Applications of Air compressor. Dewatering techniques for trenches; Stone crushing equipment.	
2	Underground & Underwater Tunnelling		09
	2.1	Various purposes for which tunnelling may be carried out, Basic terms related to tunnelling. Conventional methods of carrying out tunnelling in different types of soils/rocks. Methods for dewatering tunnels.	
	2.2	Detailed Procedure for underwater tunneling. Modern methods of tunnelling and detailed study of following equipments/ techniques in this regard. Use of drones, construction robots for aerial surveys. Use of GPS and remote sensing for setting out tunnel alignment. Jumbo – used for drilling and blasting, Blasting Techniques for quarrying stones for construction purpose. Diaphragm wall construction and other ground stabilization methods. Vertical shaft sinking machine (VSM). Tunnel Boring machine (TBM), Micro tunneling. New Austrian tunnelling method (NATM). Cut & cover method, Top to bottom construction. Tunnel lining trolley. Tunnelling for Metro projects. Difference in Tunnelling for Roads and Metros.	
3	Modern Formwork Systems and Working Techniques in Limited Space		06
	3.1	Difference in conventional and modern systems of formwork Mivan, Doka shuttering along with their advantages and disadvantages. Modular shuttering, Slip and jump form.	
	3.2	High rise construction: Concrete making on mass scale, pumping and placing booms. Tower cranes and the benefits they offer for high rise construction. Range diagram.	

	3.3	Prefabricated housing systems, Difficulties faced in the installation and operation of all these systems. Emergency housing for disaster management.	
	3.4	Working skills/tricks required for managing a site in urban/restricted space environment. Techniques for controlled demolition of buildings.	
4	Equipments For Laying of Utility Lines, Bridge Construction & Installation of Structural Steel Members.		06
	4.1	Use of ground penetrating radar (GPR) for locating underground utilities. Laying of pipes using pipeline insertion system. Installation and operation of underground power transmission lines as well as overhead transmission towers.	
	4.2	Incremental launching method and balanced cantilever method of bridge/flyover construction with reference to the recent infrastructure developed in the local and global context.	
	4.3	Equipments/techniques used for connecting structural steel components of bridge decks, terminals, malls, stadiums, car sheds, etc.	
5	Equipments/ Techniques for Setting Up of Power Generation/Supply Structures.		06
	5.1	Hydropower station. Tidal power plants. Desalinization plants. Thermal power station. Solar power station. Atomic power generation. Installation and operation of wind mills. Construction of a fuel station.	
6	Equipments/ Techniques for Construction of Transporting Facilities		06
	6.1	Construction of railway lines using track laying machine. Methods, techniques and equipments involved in the construction of Metro, mono and maglev trains. Connecting link between underground and overhead metro systems. 5D BIM integration in Metro projects.	
	6.2	Equipments required for construction and operation of an airport and sea port. Application of Drones, GIS, GPS and BIM for monitoring project progress/working of Airports and Seaports. Piling Equipment's for Jetty Construction.	
	6.3	Light Detection and Ranging (Lidar) Technique for Railways/ Highways/ Bullet train alignments.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Understand the use/applications of various conventional construction equipments and select the best out of them for a particular site requirement.
- 2 Know modern methods/equipments used for underground as well as underwater tunnelling.
- 3 Compare conventional and modern methods of formwork and get acquainted with techniques used on sites with restricted space.
- 4 Understand the techniques involved and the equipments required thereof for laying of utility lines, bridge construction and installation of structural steel members.
- 5 Gain knowledge about the setting up of different kinds of the power generating structures.
- 6 Get acquainted with the equipments/ techniques for construction of transporting facilities.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Construction Equipment & Planning. Purifoy, R.L & Ledbetter McGraw Hill
- 2 Construction Equipment & its Management. Sharma, S. C. Khanna Publishers
- 3 Tunnel Engineering Handbook Thomas R. Kuesel, Elwyn H. King, John O. Bickel Springer
- 4 Practical tunnel construction Gary B. Hemphill Wiley Publishers
- 5 Success with drones in Civil Engineering Brett Hoffstadt Kindle
- 6 Construction Technology for Tall Buildings Michael Yit Lin Chew World Scientific
- 7 The prefabricated home Colin Davies Reaktion Books
- 8 Literature/specifications/downloadable videos available on Doka and Mivaan shuttering websites.
- 9 Accelerated Bridge Construction: Best Practices and Techniques Mohiuddin Ali Khan BH Elsevier

Reference Books:

- 1 Design and Construction of Nuclear Power Plants Rüdiger Meiswinkel, Julian Meyer, Jürgen Schnell Wiley Publishers
- 2 Energy and Power generation handbook K.R Rao ASME Press
- 3 Magnetic Levitation Hyung-Suk Han Dong-Sung Kim Springer
- 4 Metro Rail Projects in India M Ramachandran Oxford
- 5 BIM Handbook Eastman,Teicholz,Sacks,Liston John Wiley and Sons
- 6 IRC:43-2015 Recommended Practice for Plants, Tools and Equipment Required for Construction and Maintenance of Concrete Roads (First Revision).
- 7 IRC-2018 Pocket book for Road Construction Equipment.
- 8 IRC: SP-97- 2013 Guidelines on Compaction Equipment for Roads Works

Semester-VI

Course Code	Course Name	Credits
CEDLO6014	Department Level Optional Course -2 Urban Infrastructure Planning	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Indian cities are currently expanding at a rapid rate, and are therefore facing immense pressure for the improvement of their services and infrastructure. Without coordination and planning for the anticipated spatial growth and densification, the infrastructure services are neglected. Such growth areas can become under-serviced places of the cities, one from which many problems of the city stem: water, sanitation and waste problems, uncontrolled pests, and crime due to poor access to water and sanitation services. To address the emerging issues of urban centre, there is a pressing need to train urban infrastructure specialists who can comprehensively plan for city's growing infrastructure needs and formulate projects for efficient infrastructure service delivery for existing areas. There are ample urban infrastructure challenges and opportunities in terms of planning; effective policy, program and project formulation for well-trained young urban infrastructure professionals with specific domain knowledge

Objectives

- 1 Describe an infrastructure system using accurate terminology;
- 2 Demonstrate an understanding of the main concepts and principles of infrastructure planning;
- 3 Identify the key features of a sustainable infrastructure system and explain how they promote sustainable development;
- 4 Apply analytical tools for infrastructure planning;
- 5 Critically evaluate infrastructure cases/projects/proposals through the lens of sustainability;
- 6 Identify the gaps between theoretical principles of sustainable infrastructure and their application in practices

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Introduction to Planning		04
	1.1	Origins and growth of cities, effects of cultural influence on physical form; Human settlements as an expression of civilizations; Basic elements of the city; Concepts of space, time, scale of cities.	
	1.2	Contribution of housing to micro and macro economy, contribution to national wealth and GDP, housing taxation, national budgets, fiscal concessions; need of affordable housing for urban poor, concept of RERA	
2	Urban Economics		06
	2.1	General introduction to principles of economics and public finance. Importance of economics in Urban Development and Planning	
	2.2	Industrial location policies, any other economic activity base policies and their impact on urban development, Role of land economics in preparation of Urban Development plans. Relevant case studies of Urban Land Economics.	
	2.3	Economic growth and development, quality of life; Human development index, poverty and income distribution, employment and livelihood; Economic principles in land use planning; Policies and strategies in economic planning, balanced versus unbalanced growth, public sector dominance; changing economic policies, implications on land.	
3	Infrastructure Planning		12
	3.1	Role of Infrastructure in Development, Elements of Infrastructure (physical, social, utilities and services); Basic definitions, concepts, significance and importance; Data required for provision and planning of urban networks and services; Resource analysis, provision of infrastructure, and land requirements; Principles of resource distribution in space; Types, hierarchical distribution of facilities, Access to facilities, provision and location criteria, Norms and standards, etc.	
	3.2	Zoning, Various growth patterns of town, Housing layouts and road networks in town, Urban aesthetics and landscaping, MRTD and Land Acquisition Acts	
		Planning and Management of Water, Sanitation and Storm Water; Water – sources of water, treatment and storage, transportation and distribution, quality, networks, distribution losses, water harvesting, recycling and reuse, norms and standards of provision, institutional arrangements, planning	

		provisions and management issues; Sanitation – points of generation, collection, treatment, disposal, norms and standards, grey water disposal, institutional arrangements, planning provisions and management issues. Storm water – rainfall data interpretation, points of water stagnation, system of natural drains, surface topography and soil characteristics, ground water replenishment, storm water collection and disposal, norms and standards, institutional arrangements, planning provisions and management issues;	
	3.3	Solid Waste Disposal and Management Basic principles, generation, characteristics, collection, disposal, management	
	3.4	Fire and Electrification, and Social Infrastructure Planning for fire protection, services and space standards, location criteria; Planning for Education, health, civic, cultural infrastructure and facilities for transport and other miscellaneous infrastructure services	
	3.5	Planning for Education, health, civic, cultural infrastructure and facilities for transport and other miscellaneous infrastructure services	
4	Traffic and Transportation Planning		07
	4.1	Evaluation of urban structure: Transport system, infrastructure and management, transport systems and their types, design and operating characteristics, urban road hierarchy, planning, and management criteria for road and junction improvements, arterial improvement techniques.	
	4.2	Traffic management, mass transit system: Problems and prospects. Review of existing traffic management schemes in Indian cities. Case study of various metro rail project envisaged for Mumbai, Navi Mumbai & Pune.	
	4.3	Economic evaluation: pricing and funding of transport services and systems, economic appraisal of highway and transport projects. Techniques for estimating direct and indirect road user costs and benefit value of time	
	4.4	Intelligent transport system (ITS) its types and applications	
5	Urban Management and Governance		06
	5.1	Introduction to Development Management and Urban Governance- Concept, approaches, components, interface with national goals and political economic system. Urban Development Management Strategies, Tools and Techniques; organizations involved Land and Real Estate Development Economic concepts of land, Land Pricing / valuation; Urban reforms and acts and policies. Overview of Urban Governance Definition, concepts, components, government and governance, hierarchy and structure, forms of governance, process of inclusion and exclusion.	

	5.2	Information System and Urban Reforms Spatial and Non - spatial information systems; Use of GIS in overlaying infrastructure facilities, use of remote sensing in identifying and mapping urban structures.	
	5.3	Present organizations and involved in urban governance with focus on MCGM, TMC and CIDCO. Urban Local Governance and Participatory Processes System, structure, functions, powers, process and resource, performance, interface with NGO's, other agencies.	
6	Environmentally Safe and Disaster Resilient Infrastructure		04
	6.1	Frame work, statement prediction and assessment of impacts of air, water, noise, cultural and socio-economic environment. Methods of impact analysis, public participation. Environmental protection international and national agencies and legislation, Environment Impact Assessment. Urban Heat Island Effect, Effect of uncontrolled growth of town	
	6.2	Disaster response planning, roles and responsibilities of various agencies Emergency operation support and management Planning for Disaster Prone Areas, Planning requisites for disaster prone areas and preventive measures, Vulnerability analysis	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Explain the concepts related to planning of modern cities, GDP contribution, RERA, affordable housing
- 2 Elaborate the economics involved in urban infrastructure planning
- 3 Envisage the various elements required for infrastructure development of a city and describe the concepts, significance and importance of each
- 4 Evaluate technical, social and economic feasibility of transportation projects within cities
- 5 Demonstrate modern tool usage for urban management and governance
- 6 Design environmentally safe and disaster resilient infrastructure

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination**80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 The Urban and Regional Planning Reader, edited by Eugenie L. Birch, Published by Routledge, 2008; ISBN 978-0-415-319
- 2 Housing: The Essential Foundations, edited by Dr. Paul Balchin, Paul Balchin, Maureen Rhoden, Edition Routledge, DOI <https://doi.org/10.4324/9780203010426>, eBook ISBN 9780203010426
- 3 New Urban Housing by Hilary French, Publisher: Yale University Press, ISBN0300115784 (ISBN13: 9780300115789)
- 4 Sociology: A Brief Introduction, by Richard T. Schaefer, Publisher: McGraw-Hill Education, ISBN 10:1259425584, ISBN 13: 9781259425585
- 5 Sociology: Principles of Sociology with an Introduction to Social Thoughts, by Rao C.N. Shankar, S. Chand Publication
- 6 Projects: Preparation, Appraisal, Budgeting and Implementation by Prasanna Chandra, Tata McGraw-Hill; ISBN0074516280 (ISBN13: 9780074516287)
- 7 Introduction to Transportation Planning, by B. Bruton, Michael J. Bruton; Published by Hutchinson Radius; ISBN0091580412 (ISBN13: 9780091580414)

Reference Books:

- 1 Modern Economics by H.L. Ahuja, 19th Revised Edition, Published by S.Chand (G/L) & Company Ltd
- 2 Economics, An Introductory Analysis by Paul A. Samuelson, William D. Nordhaus, Published July 27th 2004 by Irwin/McGraw-Hill (first published 1948), ISBN0072872055 (ISBN13: 9780072872057)
- 3 Modelling Transport, by de Dios Ortuzar and Luis G. Willumsen, 4th Edition, Wiley Publication
- 4 Principles of Urban Transport Systems Planning, by B.G. Hutchinson, Publisher: Scripta Book Co.; ISBN0070315396 (ISBN13: 9780070315396)
- 5 Traffic Engineering and Transport Planning, L. R. Kadiyali, Khanna Publishers, 1983
- 6 Remote Sensing and GIS, by Basudeb Bhatta, second Edition, Oxford University press
- 7 NEPA and Environmental Planning: Tools, Techniques, and Approaches for Practitioners; Charles H. Eccleston; CRC Press
- 8 Planning for Disaster: How Natural and Manmade Disasters Shape the Built Environment, by William Ramroth; Publisher: Kaplan Business; Original edition; ISBN-13: 978-1419593734.

Semester-VI

Course Code	Course Name	Credits
CEDLO6015	Department Level Optional Course -2 Open Channel Flow	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Civil engineers deal with the analysis and design of irrigation systems which include dams, weirs, barrages, canals, drains and other supporting systems, for which good knowledge of dynamics of open channel flow is very much essential. Hence this course is designed to study different types of flow like uniform flow, non- uniform flow, spatially varied flow, and unsteady flow occurring in open channels. Competencies developed by this course would therefore be useful for students to handle and solve the practical problems/ issues in the field of Water resource management, Water shed Management etc. It is expected that the students will be better equipped to address various engineering problems related to hydrology and hydraulics.

Objectives

- 1 Understand the nature of flow, explain the basic concepts of uniform flow and to design the best hydraulic sections in open channel.
- 2 Apply the Energy concepts of fluid in open channel and demonstrate various flow measurement devices in open channels.
- 3 Develop Dynamic equation to compute the flow profiles for Gradually varied flow and classify water profiles in prismatic channels with different slope conditions.
- 4 Illustrate the causes of Rapidly varied flow, predict the formation of hydraulic jump and its applications.
- 5 Determine different types of spatially varied flow with varying discharges and characteristics of water surface profiles.
- 6 Study and analyze the temporal flow variations in open channel and the formation of surges.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Uniform Flow		07
	1.1	Flow through open channel, Types of channels, open and covered channels, Classification of flow in channel, Geometrical properties, velocity distribution in a channel section	
	1.2	Uniform flow in open channels, Discharge through open channel, Manning's and Chezy's Equation, Determination of roughness coefficients,	
	1.3	Determination of Conveyance of a channel, Hydraulic mean depth, Normal depth and Normal velocity, computation of uniform flow	
	1.4	Most economical sections of prismatic channels, condition for maximum velocity in a circular channel, condition for maximum discharge in a circular channel	
2	Energy-Depth Relationships		07
	2.1	Specific energy, Specific energy curve, Depth- Discharge diagram, critical depth, critical slope, critical flow, alternate depths	
	2.2	Condition for maximum discharge for a given value of Specific energy	
	2.3	Momentum in open channel flow- Specific force, specific force diagram, Dimensionless specific force diagram,	
	2.4	Critical flow and its computation, Application of specific energy and discharge diagrams to channel transitions	
	2.5	Metering Flumes- Venturi flume, Standing wave flume, Parshall flume, Determination of mean velocity of flow, Measurement of discharge in Rivers	
3	Non-Uniform Flow: Gradually Varied Flow		07
	3.1	Dynamic equation of Gradually Varied Flow (GVF) in rectangular and wide rectangular channels	
	3.2	Types of slopes- channel bottom slopes and water surface slopes, classification of channel bottom slopes and surface profiles	
	3.3	Characteristics of surface profiles, Backwater curve and drawdown curve	
	3.4	Computation of GVF-Direct Step and Standard step method, Numerical methods, Graphical Integration method	

4	Non-Uniform Flow: Rapidly Varied Flow		07
	4.1	Rapidly varied flow (RVF), Hydraulic Jump, Momentum equation for the jump	
	4.2	Hydraulic jump in a rectangular channel, Froude Number before and after jump, Classification of jumps, Characteristics of jump in a rectangular channel	
	4.3	Jumps in non-rectangular channel, applications of jump, location of jump, surges in open channel	
	4.4	Use of RVF for flow measurement purpose-Sharp crested weir, Broad crested weir, Ogee spillway, sluice gate	
5	Spatially Varied Flow		06
	5.1	Importance of Spatially Varied Flow (SVF), Causes, Continuity, Momentum and Energy Equation	
	5.2	Water surface profiles, Applications, Differential Equation for SVF with increasing and decreasing discharge-	
	5.3	Relevant case studies	
6	Unsteady Flow		05
	6.1	Basic concepts of Gradually varied unsteady flow, Rapidly varied unsteady flow	
	6.2	Positive and negative surges	
	6.3	Relevant case studies	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Describe the basic nature of flow in open channels, analyze the behaviour of flow and apply basic theories to design the optimum channel sections.
- 2 Demonstrate the energy concepts in open channel and its practical applications.
- 3 Apply dynamic equation for Gradually varied flow (GVF) and evaluate water profiles at different conditions in prismatic channels.
- 4 Differentiate between GVF and Rapidly Varied Flow (RVF), analyze hydraulic jump in open channel and its importance.
- 5 Explain the spatially varied flow and classify water profiles.
- 6 Discuss the temporal variations of flow in GVF and RVF in open channel.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination**80 Marks**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Flow in Open channels: K. Subramanya, Tata Mc Graw -Hill Publishing Co. Ltd., New Delhi
- 2 Flow through Open channels: Rajesh Srivastava, Oxford University Press
- 3 Flow through Open channels: K. G. Ranga Raju, Tata Mc Graw -Hill Publishing Co. Ltd., New Delhi
- 4 Fluid Mechanics and Hydraulics: Dr S.K. Ukarande, Ane's Books Pvt. Ltd., (Revised Version 2012)
- 5 Hydraulics & Fluid Mechanics: Modi P.N. & Seth S.M, Standard book house, New Delhi

Reference Books:

- 1 Open channel Hydraulics: Chow, V.T., McGraw Hill International, New York
- 2 Open Channel Flow: Henderson F.M., McGraw Hill International
- 3 Open Channel Flow: M. Hanif Chaudhry, Prentice Hall of India.
- 4 Open channel Hydraulics: French, R.H., McGraw Hill International

Semester-VI

Course Code	Course Name	Credits
CEDLO6016	Department Level Optional Course - 1 Computational Structural Analysis	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

This subject deals with the conceptual applications of principles of mechanics of rigid and deformable bodies in Structural Engineering.

Objectives

- 1 To understand basic concepts of Matrix Methods of Structural Analysis and application of approximation techniques (Numerical Methods) in analysis of Structural Member
- 2 To analyze the behavior of structural members viz beams/plane trusses/ continuous beams/ portal frames

Detailed Syllabus

Module	Course Module / Contents	Periods
1	Basic concepts of structural analysis and methods of solving simultaneous equations	04
	1.1 Introduction, Types of framed structures	
	1.2 Static and Kinematic Indeterminacy, Equilibrium equations	
	1.3 Compatibility conditions, principle of superposition, Energy principles, Equivalent joint loads	
	1.4 Methods of solving linear simultaneous equations- Gauss elimination method, Cholesky method and Gauss- Seidel method.	

2	Fundamentals of Flexibility and Stiffness Methods		07
	2.1	Concepts of stiffness and flexibility	
	2.2	Local and Global coordinates	
	2.3	Development of element flexibility and element stiffness matrices for truss, beam and grid elements	
	2.4	Force- transformation matrix	
	2.5	Development of global flexibility matrix for continuous beams, plane trusses and Rigid plane frames	
	2.6	Displacement- transformation matrix, Development of global stiffness matrix for continuous beams, plane trusses and rigid plane frames.	
3	Analysis Using Flexibility Method (Including Secondary Effects)		07
	3.1	Continuous beams, plane trusses and rigid plane frames	
4	Analysis Using Stiffness Method (Including Secondary Effects)		07
	4.1	Continuous beams, plane trusses and rigid plane frames	
5	Direct stiffness Method		07
	5.1	Stiffness matrix for truss element in local and global coordinates	
	5.2	Analysis of plane trusses	
	5.3	Stiffness matrix for beam element	
	5.4	Analysis of continuous beams and orthogonal frames.	
6	Finite Element Method		07
	6.1	Historical Background – Mathematical Modeling of field problems in Engineering	
	6.2	Governing Equations – Discrete and continuous models	
	6.3	Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value	
	6.4	Basic concepts of the Finite Element Method.	
	6.5	One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 Formulate force displacement relation by flexibility and stiffness method
- 2 Analyze the plane trusses, continuous beams and portal frames by transformation approach
- 3 Analyze the structures by direct stiffness method
- 4 Explain the basics of finite element formulation.
- 5 Apply finite element formulations to solve one dimensional Problems

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Matrix Methods of Structural Analysis, S. S Bhavikatti, WILEY
- 2 Matrix Analysis of Framed Structures, Weaver, W., and Gere, J.M., CBS Publishers and distributors pvt. Ltd., 2004.
- 3 Computational Structural Mechanics, Rajasekaran, S., and Sankarasubramanian, G., PHI, New Dehi, 2001.
- 4 Introductions to Matrix Methods of Structural Analysis, Martin, H, C., McGraw-Hill, New York, 1966.
- 5 Structural Analysis A Matrix Approach, G. S. Pandit, S. P. Gupta, TATA McGraw Hill
- 6 Matrix Computer Analysis of Structures, Rubinstein, M.F., Prentice-Hall

Reference Books:

- 1 Introductory Methods of Numerical Analysis, S S. Sastry, ASIN : 8120345924, Publisher-Prentice Hall India Learning Private Limited.
- 2 Introduction to the Finite Element Method, Desai Abel, CBS Publishers and distributors
- 3 Introduction to Finite Elements in Engineering, Chandrupatala, Belugundu, Pearson Education Publisher : Pearson; 4th edition (20 December 2011)
- 4 Numerical Methods for Engineers, Steven Chapra, Tata McGraw Hill

Semester-VI

Course Code	Course Name	Credits
CEDLO6017	Department Level Optional Course -2 Traffic Engineering and Management	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Traffic Engineering Management follows the Transportation Planning and is the specialized branch of the Highway Engineering, which introduces the concepts of characterizing traffic, various modeling approaches, and design of facilities to control and manage traffic. A key feature of the course is that it is well connected with the current design and analysis practice stipulated in national standards, and manuals. Therefore, it deals with the application of scientific principles, tools, techniques and findings for safe, rapid, economical and efficient movement of people and vehicles.

Objectives

- 1 To understand the concepts of traffic characteristics, traffic surveys to be conducted for planning any transportation network or judging the adequacy of the existing one
- 2 The application of various statistical tools to the analysis of the large data base emerging out of extensive traffic surveys and transportation and traffic planning.
- 3 To understand the concept of various features of the intersection infrastructures, their necessity, pros and cons, design or planning principles and subsequently, to design / plan the features such as channelization, island, speed change lanes and parking facility.
- 4 To understand the concept of highway capacity and such other components such as Passenger Car Unit and Level of Service affecting the Capacity; and Speed- Flow- Density Relationship and various theories describing these relationships.
- 5 To understand the importance of Highway Safety and implementation of Traffic System Management (TSM) Measures and subsequent to study the various Traffic Control Devices and aspects of Highway Lighting.
- 6 To explore the future of traffic engineering in the form of Intelligent Transportation system

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Traffic Characteristics and Surveys		03
	1.1	Scope, Traffic Elements - Characteristics-vehicle, road user and road - Traffic studies-speed & delay, traffic volume, O & D, parking and accidents - Sample size, study methodology - Data analysis & inferences.	
2	Application of Statistics in Traffic Engineering		05
	2.1	Various probability distributions & their applications - Parameter estimation - Hypothesis testing - Random variables	
	2.2	Estimation and analysis of simple regression models - Correlation coefficients - Analysis of correlation coefficients	
	2.3	Application of queuing theory as applied to traffic flow problems for study state conditions	
3	Intersection Design		10
	3.1	Types of intersections - Conflict diagrams –Control hierarchy- Design of rotaries (Indo-HCM 2017) & at-grade intersections – Signal design as per IRC:93- Grade separated intersections & their warrants, coordination of signals, types of area traffic control	
4	Traffic Flow Theory		10
	4.1	Measurement, microscopic and macroscopic Study of Traffic Stream Characteristic -Flow, Speed and Density; pace – Time diagram, Headways, Speeds, Gaps and Lags; gap acceptance. Fundamental Equation of Traffic Flow, Speed-Flow-Density Relationships, Shock Wave Theory Passenger's car units, Factors affecting PCU and methods to determine PCU, level of service, factor affecting capacity and level of service. Capacity and level of service suggested for different road facilities as discussed in Indo-HCM 2017, review of flow density speed studies, Light hill and Whitham's theory, fundamentals of traffic stimulation modeling.	
5	Traffic Management and Road safety Audit		07
	5.1	Various measures for traffic systems management and travel demand management-Congestion management -cost effective Management, their scope, relative merits and demerits. (Pedestrians and Cyclist Management) (IRC SP:55-2014)	
	5.2	Highway Lighting: Important definitions, law of illumination, discernment by artificial lighting, mounting height, spacing lantern arrangements, types of lamps, lighting of some important highway structures.	
	5.3	Accidents: Accident cause, recording system, analysis and	

		preventive measures, accident cost, alternative methodologies for calculation.	
	5.4	Road Safety Audit: Global & Local perspective – Road safety issues – Road safety programmers – Types of RSA, planning design, construction & operation stage audits – Methodology – Road safety audit measures, road safety audit process as per IRC: SP-88-2010	
6	Intelligent Transportation System		04
	6.1	Overview of ITS implementations in developed countries, ITS in developing countries. Study of IRC: SP-110-2017	
	6.2	Historical Background, Benefits of ITS – Introduction to Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), Traffic control and monitoring aspects.	
	6.3	Application of ITS: Advanced Traffic Management Systems (ATMS) Advanced Vehicle Control Systems (AVCS), Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS), Automated Highway Systems	
Total			39
Contribution to Outcome			

On completion of this course, the students will be able to:

- 1 Understand different characteristics of the road users and vehicles from their consideration and view point in the traffic engineering and transportation planning.
- 2 Conduct different traffic surveys, analyzing the data collected as a part of such studies and interpreting it with the help of the different statistical models.
- 3 Explain the concepts of PCU and LOS, their implication in determination of the capacity using Speed-Flow-Density relationships.
- 4 Discuss the aspects associated with road safety, its audit and different TSM measures.
- 5 Discuss transportation planning and ascertain the financial viability of any transportation network in the inception stage itself.
- 6 Improve the effectiveness and efficiency of transportation systems through advanced technologies in Information systems and communication.

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2002.
- 2 Srinivasa Kumar .R ,Introduction to Traffic Engineering, The Orient Blackswan; south Asian Edition, 2018.
- 3 Chakroborty P., Das N., Principles of Transportation Engineering, PHI, New Delhi, 2003
- 4 Khanna S.K., Justo C.E.G., Highway Engineering, Nem Chand & Bros., Roorkee, 2001
- 5 Khisty C J, Lall B. Kent; Transportation Engineering-An Introduction, Prentice-Hall, NJ, 2005
- 6 May, A.D., Traffic Flow Fundamentals, Prentice – Hall, Inc., New Jersey, 1990.
- 7 O’Flaherty C A, Highways- Traffic Planning & Engineering, Edward Arnold, UK
- 8 Drew, D.R., Traffic Flow Theory and Control, McGraw-Hill, New York.
- 9 Benjamin J. R., Cornell C. A., Probability Statistics and Decision for Civil Engineers, McGraw-Hill, 1970.
- 10 Asad J. Khattak , Intelligent Transportation Systems: Planning, Operations, and Evaluation, CRC Press

Reference Books:

- 1 Transportation Engineering and Planning Papacostas, C. S., Prevedouros, P. D., PHI Learning Pvt. Ltd.
- 2 Transportation Engineering: Khisty, C.J. and Lall, K.B.; PHI Learning Pvt.Ltd.
- 3 Introduction to Urban Transport Systems, Planning: Hutchinson, B.G.; McGraw-Hill.
- 4 Economics of Transportation: Fair and Williams, Harper and Brothers, Publishers, New York.
- 5 Highway Capacity Manual, Transportation Research Board, National Research Council, Washington D.C.
- 6 Relevant IRC Codes amended time to time.

Semester-VI

Course Code	Course Name	Credits
CEDLO6018	Department Level Optional Course -2 Introduction to Offshore Engineering	03

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	3 Hours	-	-	-	100

Rationale

Offshore Engineering discipline deals with the design and construction of structures intended to work in the ocean environment. The majority of offshore structures are used in the Oil and Gas industry. Offshore construction is the installation of structures and facilities in a marine environment. Civil Engineering graduates will be able to work in the specialized field of ocean and coastal environment.

Objectives

- 1 To understand the complexities in offshore construction and obtaining resources from the ocean.
- 2 To addresses the general engineering concepts that are fundamental to offshore engineering.
- 3 To understand types of sites and platform structures, key engineering systems and ocean environmental monitoring

Detailed Syllabus

Module	Course Module / Contents		Periods
1	Introduction:		05
	1.1	History and current state of the art of offshore structures, Definition of Offshore Structures, Met ocean Engineering: wind, wave and current loads on offshore structures	
2	Environment & Construction:		06
	2.1	Offshore environment, Construction and launching, offshore project management,	
3	Ocean Construction:		06

	3.1	Types of Platforms: Jackets, Tension Leg Platforms (TLP), Semisubmersibles, Jack-ups, Concrete Gravity, deep water construction in ocean, offshore site investigations	
4	Offshore Pipelines:		06
	4.1	Hydrostatic, hydrodynamic analysis and structural design	
5	Buoys and Mooring systems:		08
	5.1	Buoys and Mooring systems Mooring configurations, advantages and disadvantages	
6	Design Criteria:		08
	6.1	Introduction to probabilistic design, extreme load & strength & fatigue, basics of anchoring and mooring system, riser system, Scaling laws & Model testing, Challenges in Deepwater testing: deep-water installations, constructions challenges.	
Total			39

Contribution to Outcome

On completion of this course, the students will be able to:

- 1 To know various offshore construction methodologies
- 2 To addresses the general engineering concepts during construction stages.
- 3 To handle complexities and key engineering systems in ocean environment

Internal Assessment

20 Marks

Consisting of two Compulsory Class Tests –

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in first test).

Average of marks will be considered for IAE.

End Semester Examination

80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

Recommended Books:

- 1 Subrata K. Chakrabarti (2005): Handbook of offshore engineering Volume–I & II, Elsevier, The Boulevard Langford Lane, Kidlington, Oxford OX5 1GB, UK.
- 2 Deo M C (2013):Waves and Structures, <http://www.civil.iitb.ac.in/~mcdeo/waves.html>
- 3 American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Load and Resistance Factor Design, 1st Edition, 1993. (TP690.A642 RP2A-LRFD)
- 4 American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design, 21st ed., 2000. (TP690.A642 RP2A-WSD).

Semester-VI

Course Code	Course Name	Credits
CEL601	Design and Drawing of Steel Structures (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

- 1 To estimate the design loads on steel structures as per IS 875
- 2 To analyze the member forces by any suitable method.
- 3 To design the members for axial, flexure and shear forces.
- 4 To prepare the detailed design report and fabrication drawings by manual or CAD software.

Course Outcomes:

At the end of the course, learner will be able to:

- 1 Calculate dead, live and wind loads on the structure.
- 2 Analyze the structure by analytical/graphical method.
- 3 Use steel table for selecting appropriate section.
- 4 Design the members for various load combinations.
- 5 Design the bolted and welded connection.
- 6 Read and Prepare the detailed fabrication drawing and design report.

The Project shall be given to a group of students consisting of not more than 10 students.		
List of the Projects		
Schedule	Detailed Content	Lab Session / Hr.
Project 1	Design and drawing of steel roof truss for industrial shed should consist of the following items.	
1 st Week	Introduction, problem statement, Calculation of panel point DL, LL, and WL on truss.	02
2 nd Week	Analysis of truss by graphical method/ any software and calculation of design loads in members	02
3 rd Week	Design of purlins, Principal rafter, Main Tie, Design of remaining members of truss. etc.	02
4 th Week	Design of bolted /welded connections and design of sliding and hinged supports including anchor bolts	02
5 th Week	To generate/draw fabrication drawings on full imperial size drawing sheet and design report on A4 size pages.	02
6 th Week	To generate fabrication drawings and design report including estimation of steel required.	02
Project 2	Design and drawing of floor beam system for steel building G+1 should consist of the following items	
7 th Week	Introduction, problem statement and to draw grid floor plan.	02
8 th Week	Calculation of DL, LL on slab, beams etc. and to analyze frame for BM and SF.	02
9 th Week	Calculation of design loads on columns and footing.	02
10 th Week	Design of beams, columns and footings.	02
11 th Week	Design of beam end and beam-column connections.	02
12 th Week	To generate/draw fabrication drawings on Full imperial size drawing sheet and design report on A4 size pages.	02
13 th Week	To generate fabrication drawings and design report including estimation of steel required.	02

Assessment:

• Term Work

Shall consist of design report and fabrication drawings for the above projects and Site visit report related to this course. Distribution of marks for Term Work shall be as follows:

Project 1+Project 2+ Site visit report : 20 Marks

Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

- **End Semester Oral Examination**

Oral Examination will be based on Sketching Examination, Term Work and Entire syllabus

Recommended Books:

- 1 Design of Steel Structure by N. Subramanian, Oxford University Press, New Delhi.
- 2 Limit state design of steel structures by S. K. Duggal, McGraw Hill Education (India) Pvt. Limited, New Delhi.
- 3 Design of steel structure by Limit State Method as per IS: 800- 2007 by Bhavikatti S. S., I.K. International Publishing House, New Delhi.
- 4 Design of Steel Structures by K. S. Sai Ram, Pearson Education, New Delhi.
- 5 Limit state design of steel structures as per IS 800/2007. by S. Kanthimathinathan. I.K. International Publishing House, New Delhi.
- 6 Relevant Indian Specifications, Bureau of Indian Standards, New Delhi.

Reference Books:

- 1 Design of Steel Structure by Allen Williams
- 2 Practical Design of Steel Structure by Karuna Moy Ghosh, Whittles Publishing
- 3 Structural design and drawing by D. Krishnamurthy, CBS Publishers, New Delhi.
- 4 Teaching Resources Material for steel structures by INSDAG Kolkata.

Semester-VI

Course Code	Course Name	Credits
CEL602	Water Resources Engineering (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

- 1 To study different irrigation engineering methods and water requirement of crops.
- 2 To study hydrological cycle, its elements and plotting of hydrographs.
- 3 To study and calculate discharge from aquifers.
- 4 To study control level fixation for reservoir, Dams i.e gravity dam, its various components and analysis and suitable conditions of earthen dam and its seepage analysis.
- 5 To study importance of silt theories and its design considerations.
- 6 To study Canal headwork, its distribution system and design of canal structures.

Course Outcomes:

At the end of the course, learner will be able to:

- 1 Classify various techniques of water distribution and compute water requirement of crops.
- 2 Discuss in detail about hydrological process and interpret plotting of hydrographs.
- 3 Apply their knowledge on well hydraulics and compute discharge from an aquifer.
- 4 Classify and describe various hydraulic structures such as dams and carry out its analysis for structural stability.
- 5 Compare different silt theories related to irrigation channel and design the same.
- 6 Identify and classify different canal head works - its distribution system and canal structures.

List of Experiments (Minimum Five)		
Module	Detailed Content	Lab Session / Hr.
Assignment		
1	Assignment no 1: Irrigation projects in India and Numerical based Water requirement of crops.	02
2	Assignment no 2: Numerical based on missing data, hydrographs.	02
3	Assignment no 3: Numerical based on yield of aquifer.	02
4	Assignment no 4: Numerical based on stability of gravity dam, seepage line (earthen dam)	02
5	Assignment no 5: Numerical based on Silt Theories	02
6	Assignment no 6: Case study on different canals in India and abroad.	02
Model Preparation (if possible, prepare any one model from below suggested topic)		
1	Prepare a model for any one water distribution technique referring to introductory chapter.	06
2	Prepare model for Dam (Gravity or Earthen Dam).	

Assessment:

• Term Work

Comprises of Assignments which has to be submitted by each student individually and preparation of model can be worked out in group of 6 members each.

Distribution of marks for Term Work shall be as follows:

Assignments : 20 Marks

Attendance : 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

• End Semester Oral Examination

Pair of Internal and External Examiner should conduct oral examination.

Reference Books:

- 1 Irrigation and Water Power Engineering: B.C. Punmia, Pande B.B. Lal, A.K Jain. Laxmi Publications Pvt, Ltd. New Delhi.
- 2 Irrigation Engineering and Hydraulic Structures: S.K. Ukarande, Ane Books Pvt. Ltd. ISBN-9789383656899.
- 3 Irrigation Water Resources and Water Power Engineering: P.N. Modi, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
- 4 Irrigation Engineering and Hydraulics Structures: S. K. Garg, Khanna Publishers. Delhi.
- 5 Design of Irrigation Structures: S. K. Sharma, S. Chand and Co.
- 6 Theory and Design of Irrigation Structures: R. S. Varshney and R, C. Gupta, Nem Chand
- 7 Engineering for Dams, Vol. I to III: Crager, Justin and Hinds, John Wiley
- 9 Design of Small Dams: USBR.
- 10 Hydro Power Structures: R. S. Varshney, Nem Chand and Bross.
- 11 Concrete Dams: R. S. Varshney, Oxford and IBH Publishing Co.

Semester-VI

Course Code	Course Name	Credits
CEL603	Geotechnical Engineering-II Lab	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objective:

- 1 To study consolidation characteristics of soil.
- 2 To study and examine shear strength parameters of soil.
- 3 To Study and determine the strength of sub-grade soil.
- 4 To Study and determine swelling pressure of soil.
- 5 To gain the knowledge of stress distribution in soil.
- 6 To gain the knowledge of various geotechnical software.

Course Outcomes:

At the end of the course Students will be able to

- 1 Determine consolidation parameters such as coefficient of compressibility, coefficient of volume change, coefficient of consolidation.
- 2 Determine cohesion and angle of shearing resistance for various soil types.
- 3 Determine the CBR value of soil for pavement design.
- 4 Determine swelling pressure of soil.
- 5 Understand the concept of stress distribution in soils due to vertically applied load.
- 6 Solve design problems using geotechnical software.

List of Experiments (Minimum Five)

Module	Detailed Content	Lab Session Hrs.
1	Determination of pre-consolidation pressure and coefficient of consolidation from one dimensional consolidation test	02

2	Determination of shear strength parameters using direct shear test	02
3	Determination of shear strength parameters using unconsolidated undrained tri-axial compression test	02
4	Determination of undrained cohesion using unconfined compression test	02
5	Determination of shear strength of soft clays by vane shear test	02
6	Determination of CBR value using CBR test	02
7	Determination of swelling pressure of clays	02

Assignment:

a) Term Work Assessment

Assignments should contain at least 15 numerical problems covering the entire syllabus.

b) One assignment shall be given on either vertical stress distribution in soils or a design problem using geotechnical engineering software. The teacher is expected to impart the knowledge to the students about the concept of stress distribution of soils or design problem using software. The questions related to stress distribution in soils or design problem using software shall **NOT** be asked in the theory examination. However, it shall be treated as a part of term work submission. It shall preferably cover the following points:

- Vertical stress distribution in soils: Estimation of vertical stress in soil due to surface load using Boussinesq equation.

OR

- Design problem using software: Introduction to any geotechnical software like Geo 5, PLAXIS, FLAC, MIDAS GTS-NX etc.

Distribution of Term Work Marks

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	15 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

- End Semester Oral Examination : 25 marks

Reference Books:

- 1 Engineering Soil Testing: Shamsheer Prakash, P.K. Jain; Nem Chand & Bros
- 2 Soil Testing for Engineers: William T. Lambe; John Wiley and Sons, Inc.
- 3 Soil Mechanics Laboratory Manual: Brij Mohan DAS; Oxford University Press Inc.
- 4 Soil Mechanics in Engineering Practice: Karl Terzaghi, Ralph B. Peck, Gholamreza Mesri; John Wiley and Sons, Inc.
- 5 Soil Mechanics and Foundations: Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar; Laxmi Publications
- 6 Soil Mechanics in Theory and Practice: Alam Singh; Asia Publishing House
- 7 Soil Mechanics and Foundation Engineering: V. N.S. Murthy; Saitech Publications
- 8 Relevant Indian Standard Specifications Code: BIS Publications; New Delhi

Semester-VI

Course Code	Course Name	Credits
CEL604	Environmental Engineering (Lab)	01

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

- 1 To analyse engineering skill related to water and wastewater sample.
- 2 To apply decision related to treatment of water and wastewater based on standards.
- 3 To understand the fundamental characteristics of municipal solid waste.
- 4 To acquire knowledge on the severity of air pollution and suggest remedies and preventive measures.
- 5 To understand the basic concepts of noise and its measurement.

Course Outcomes:

At the end of the course, learner will be able to:

- 1 Impart the knowledge on quality or characteristic of water and wastewater sample.
- 2 Interpret the required treatment for water and wastewater based on standards and norms.
- 3 Impart the knowledge on quality of solid waste.
- 4 Measure the concentration of particulate matters, dust and dispersed pollutants in air.
- 5 Inspect the levels of noise and interpret the results.

List of Experiments (Any eight to be performed)		
Module	Detailed Content	Lab Session / Hr.
1	Determination of pH of water/ sewage sample /solid waste.	02
2	Determination of Turbidity in water sample.	02
3	Determination of Total Solids, suspended solids, dissolved solids, volatile solids.	02
4	Determination of chlorides.	02
5	Determination of Optimum dose of coagulant by using Jar Test.	02
6	Determination of Dissolved Oxygen.	02
7	Determination of Residual chlorine	02
8	Determination of air quality using High Volume air Sampler.	02
9	Determination of Level equivalent of Noise	02
10	Determination of Bio Chemical Oxygen Demand of sewage sample	02
11	Determination of Chemical Oxygen Demand of sewage sample.	02
12	Determination of moisture content of solid waste.	02

Assessment:

• Term Work

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	15 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

• End Semester Oral Examination

Oral exam will be based on experiments performed, site visit and theory syllabus.

Reference Books:

- 1 Water Supply Engineering: S. K. Garg, Khanna Publication.
- 2 Environmental Engineering Vol II: Garg, S. K., Khanna Publishers New Delhi.
- 3 Water Supply Engineering: P.N. Modi, Rajsons Publication.
- 4 Environmental Engineering: *B. C. Punmia*, Laxmi Publications, New Delhi.
- 5 Solid waste management in developing countries: A.D. Bhide and B.B. Sundaresan.
- 6 CPHEEO Manual on Water Supply and Treatment.
- 7 CPHEEO Manual on Sewage and Treatment.

Semester-VI

Course Code	Course Name	Credits
CEL605	Skill Based Lab Course-III	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Course Objectives:

- 1 To Provide hands on training on analysis, modelling and design of R. C. C. Framed structure and Steel structure.
- 2 To prepare the database and perform its statistical analysis using relevant software.
- 3 To understand and apply the basic functions of excel for data analysis, preparation of programs and generation of reports having mathematical and pictorial representation.
- 4 To design reliable and sustainable transportation systems.
- 5 To evaluate the demand of water for given population and create the proper distribution system.
- 6 To Apply the basic knowledge of various computer languages to create the programme pertaining to civil engineering domain.

Course Outcomes:

At the end of the course, learner will be able to:

- 1 To understand the functions involved various softwares related to civil engineering field.
- 2 To perform different functions of the software related to analysing modelling and designing the structure, creation of database and its analysis.
- 3 To describe and represent the data obtained from site, experimental work in various formats as per industrial requirements
- 4 To import road geometric design into the software as well as relate with the design standards applied into the software.
- 5 To design the effective distribution network system for the distribution of water resources.
- 6 To apply the knowledge to create the programme in excel and various computer languages for solving problems pertaining to civil engineering field.

List of Experiments (Minimum Eight)		
Module	Detailed Content	Lab Session / Hr.
Analysis, Modelling and Design of structure using professional software		15
1	Introduction to structural engineering software. Study of basic commands and tools.	03
2	Analysis of determinate and in-determinate structure. Extraction of shear force and bending moment diagram for given structure manually as well using software	03
3	Developing a model of simple plan of a building (square or rectangular)	03
4	Analysis of frames – R. C. C. framed structure	03
5	Analysis of frames – Steel structure	03
Preparation and analysis of database using open-source software		03
6	Introduction to statistical software – Basic function required for preparing database, statistical analysis of the data and its representation	03
Excel		15
7	Introduction to Excel – Basic function required for preparing database, statistical analysis of the data and its graphical representation a. Creation of database of result obtained from Traffic volume survey and its analysis b. Creating database of results obtained from laboratory experiments and its analysis	03
8	Preparation of programme using various functions in excel or any other relevant exercise in civil engineering field 1. Mix design of concrete 2. Design of pavement 3. Design of structural members	03
9	Preparation of checklist for various items of work in building construction for quality control, Preparation of various reports like Daily progress report, Daily Labour report, Weekly progress report, Weekly Labour report, Geotechnical reports, Audit reports	03
10	Use of transportation engineering related software for creation of contour, creation of cross section, setting horizontal and vertical alignment and calculation of cut and fill	03
11	Use of open-source software for designing and simulation of water distribution network	03
Programming using open-source software C or C++ or java or python		06
12	Introduction to programming software, Basics commands and tools for development of programme related to civil engineering field	03
13	Programming for Civil Engineers with content related to any domains of Civil Engineering problem solving using programming software.	03

Assessment:**• Term Work**

Including Laboratory Work comprising of minimum 5 software generated reports/sheets/program outputs along with minimum 5 assignments or reports, distribution of marks for Term Work shall be as follows:

Laboratory Work	: 10 Marks (comprising of min. 5 software generated sheets/program outputs)
Assignments	: 10 Marks (comprising of min. 5 Reports)
Attendance	: 05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.

End Semester Oral Examination

Oral exam will be based on Laboratory Work performed.

Reference Books:

- 1 Software manuals
- 2 IS 456, IS 800
- 3 Refereed Journal papers on Software applications
- 4 Manual on Water Supply and Treatment, C. P. H. E. E. O., Ministry of Urban Development, Government of India, New Delhi
- 5 The 'C' Programming Language, B.W Kernighan & D.M Ritchie, Prentice Hall of India
- 6 Statistics for Managers, Using Microsoft Excel, 8th Edition, David M., Levine, Pearson India Education service Pvt ltd.

Recommended Books:

- 1 Excel with Microsoft Excel: Comprehensive & Easy Guide to Learn Advanced MS Excel Paperback – 1 January 2019 by Naveen Mishra (Author); Publisher: Penman Books; Publication date: 1 January 2019; ISBN-10: 9389024153; ISBN-13: 978-9389024159
- 2 Structural Modeling, Analysis & Design Using Staad Pro Software Paperback – 15 October 2015 by Vignesh Kumar M (Author); Publisher: LAP Lambert Academic Publishing; Genre: Business & Economics; ISBN: 9783848447671, 9783848447671
- 3 Discovering Statistics Using SPSS for Windows: Advanced Techniques for the Beginner; By Andy P. Field; Publisher: Sage Publications; ISBN: 9780761957553, 0761957553
- 4 Quality Management in Construction Projects; By Abdul Razzak Rumane; Copyright Year 2018; ISBN 9780367890032; Published December 10, 2019 by CRC Press
- 5 Introduction to Machine Learning with Python: A Guide for Data Scientists Paperback – 7 October 2016; by Andreas C. Mueller (Author), Sarah Guido (Author); ISBN-10: 1449369413; ISBN-13: 978-1449369415, 1st Edition; Publisher O'Reilly

Semester-VI

Course Code	Course Name	Credits
CEM601	Mini Project -2B	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
-	-	-	-	-	25	-	25	50

Rationale

Civil engineers deal with many challenges on daily basis. The civil engineering industry's growth has been need based and society centric. Computers and IT systems have touched almost every part of our lives and inter-disciplinary approach is way of life ahead. Mumbai University proposed Mini projects in the syllabus so that the budding civil engineers can connect with the world outside their textbooks and have the idea of future course. The Mini project should actually provide solution to a typical problem after a brainstorming and in a stipulated period. The solutions based on software, development of computer application, or IT systems based on artificial intelligence or IOT are expected from civil engineering students. The competitions ahead will give students the experience of the civil engineering industry's real-world problems and make students brainstorm ideas, learn, and explore the civil engineering industry.

Course Objectives:

- 1 To recognize societal problems and convert them into a problem statement by understanding of facts and ideas in a group activity. (BTL-2)
- 2 To deal with new problems and situations by applying acquired knowledge, facts, techniques and rules in a different way. (BTL-3)
- 3 To examine and break information into parts, by analyzing motives or causes. (BTL-4)
- 4 To learn evaluating information, validity of ideas and work based on a set of criteria. (BTL-5)
- 5 To create solutions by compiling information together in a novel way. (BTL-6)

- 6 To design software based model, application or IT system by combining elements in a new pattern or proposing new solutions. (BTL-6)

Course Outcomes:

At the end of the course, learner will be able to:

- 1 Identify problems based on societal /research needs and formulate a solution strategy.
- 2 Apply fundamentals to develop solutions to solve societal problems in a group.
- 3 Analyze the specific need, formulate the problem and deduce the interdisciplinary approaches, software-based solutions and computer applications.
- 4 Develop systematic flow chart, evaluate inter disciplinary practices, devices, available software, estimate and recommend possible solutions.
- 5 Draw the proper inferences from available results through theoretical/experimental/simulations and assemble physical systems.
- 6 Create devices or design a computer program or develop computer application.

- **Guidelines for Mini Project -2B**

Expected outcome is Software based, “**A Computerized Model/ A software/ A computer program, an IOT application or A Computer or Mobile based application**”.

Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.

Students should find ‘List of Mini project- 2B problems’ in University web portal www.mu.ac.in, and in consultation with faculty supervisor/head of department/internal committee of faculties select the title.

Students shall submit implementation plan in the form of Gant/PERT/CPM chart, which will cover weekly activity of mini project.

A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

Students shall convert the best solution into A Computerized Model/ a software/ A computer program, an IOT application or A Computer or Mobile based application using various components of their domain areas and demonstrate.

The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that Students come out with original solution.

However, based on the individual students or group capability, with the mentor’s recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a

completely new project idea in even semester. This policy can be adopted on case-by-case basis.

List of approved problems for Mini Project -2B:	
S501:	Development for Mobile App for Smart Traffic Management System Using Internet of Things
S502:	Development for Mobile App for IoT based smart traffic signal monitoring system using vehicle Count.
S503:	Development of (AI Based) software or mobile App. To identify quantity of (bricks, pipes, bars etc.) from photograph.
S504:	Development of (AI Based) software or mobile App. To identify size of cracks in distressed structure from coin aimed photograph.
S505:	Development of (AI Based) software or mobile App. To identify size of cracks in distressed structure.
S506:	Development of (AI Based) software or mobile App. For Assessment of Irrigation Water Quality Index.
S507:	Development of (AI Based) software or mobile App. For Ground Water Quality monitoring in industrial zone.
S508:	Development of (AI Based) software or mobile App Advanced Earthquake Resistant Techniques
S509:	Development of Remote Monitoring System For Civil Engineering projects.
S510:	Application of Geographic Information system using Quantum GIS software.
S511:	Development of (AI Based) software or mobile App for Building Information Modelling using ArchiCAD/ Revit architecture software.
S512:	Development of (AI Based) software or mobile App Digitization of Slump cone Test.
S513:	Development of (AI Based) software or mobile App Digitization of other mechanical Tests.
S514:	Development of (AI Based) software or mobile App Civil Engineering quantity calculator.
S515:	Development of (AI Based) software or mobile App Digitization of Non-destructive testing of concrete-various methods.
S516:	Development of (AI Based) software or mobile App Mapping of area using Total Station and plotting the same on 3-d drafting.
S517:	Preparation of Excel VBA sheet for solving Survey, Soil Mechanics, Structural Analysis problems.
S518:	Development of (AI Based) software or mobile App Smart street lights and fault location monitoring in the cloud over IoT
S519:	Development of (AI Based) software or mobile App IOT based smart irrigation system
S520:	Development of (AI Based) software or mobile App Smart cities: Traffic data monitoring over IoT for easy transportation/alternative route selection
S521:	Development of (AI Based) software or mobile App Dam gate level monitoring for water resource analysis and dam gate control over IoT.
S522:	Development of (AI Based) software or mobile App Smart colony: RFID based gate security system, street lights, and water pump automation.
S523:	Development of (AI Based) software or mobile App Agriculture automation using GSM (soil moisture level control and motor control)

(This is tentative list, this list will be continuously updated by contributions from faculty, industry and alumni.)

Guidelines for Assessment of Mini Project:

- **Term Work**

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below:

Marks awarded by guide/supervisor based on log book	: 10 Marks
Marks awarded by review committee	: 10 Marks
Quality of Project report	: 5 Marks

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

- **Assessment criteria of Mini Project:**

Mini Project shall be assessed based on following criteria:

- Quality of survey/ need identification
- Clarity of Problem definition based on need.
- Innovativeness in solutions
- Feasibility of proposed problem solutions and selection of best solution
- Cost effectiveness
- Societal impact
- Innovativeness
- Cost effectiveness and Societal impact
- Full functioning of working model as per stated requirements
- Effective use of skill sets
- Effective use of standard engineering norms
- Contribution of an individuals as member or leader
- Clarity in written and oral communication

In one year, project, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.

In case of half year project all criteria in generic may be considered for evaluation of performance of students in mini project.

- **Guidelines for Assessment of Mini Project Practical/Oral Examination:**

Report should be prepared as per the guidelines issued by the University of Mumbai.

Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years and approved by head of Institution.

Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

- **Mini Project shall be assessed based on following points:**

Quality of problem and Clarity

Innovativeness in solutions

Cost effectiveness and Societal impact

Full functioning of working model as per stated requirements

Effective use of skill sets

Effective use of standard engineering norms

Contribution of an individuals as member or leader

Clarity in written and oral communication



No. AAMS(UG)/87 of 2021-22

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/39 of 2018-19, dated 22nd June, 2018 relating to the revised syllabus as per (CBCS) for the T.E. & B.E. in Computer Engineering (Sem - V to VIII).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Computer Engineering at its meeting held on 11th May, 2021 and subsequently passed by the Board of Deans at its meeting held on 11th June, 2021 vide item No. 6.15 (R) have been accepted by the Academic Council at its meeting held on 29th June, 2021 vide item No. 6.15 (R) and that in accordance therewith, the revised syllabus (Rev - 2019 'C' Scheme) for the B.E. in Computer Engineering (T.E. - Sem. V and VI.) has been brought into force with effect from the academic year 2021-22 accordingly. (The same is available on the University's website www.mu.ac.in).

MUMBAI - 400 032
30th September, 2021


(Dr. B.N. Gaikwad)
I/c REGISTRAR

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.15 (R) 29/06/2021

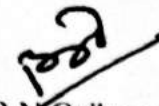
No. AAMS(UG)/ 87-A of 2021-22

MUMBAI-400 032

30th September, 2021

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology,
- 2) The Chairman, Ad-hoc Board of Studies in Computer Engineering,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Co-ordinator, University Computerization Centre,


(Dr. B.N. Gaikwad)
I/c REGISTRAR

Copy to :-

1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),
2. The Deputy Registrar, College Affiliations & Development Department (CAD),
3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),
4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),
5. The Deputy Registrar, Executive Authorities Section (EA),
6. The Deputy Registrar, PRO, Fort, (Publication Section),
7. The Deputy Registrar, (Special Cell),
8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,
9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. P.A to Hon'ble Vice-Chancellor,
2. P.A Pro-Vice-Chancellor,
3. P.A to Registrar,
4. All Deans of all Faculties,
5. P.A to Finance & Account Officers, (F.& A.O),
6. P.A to Director, Board of Examinations and Evaluation,
7. P.A to Director, Innovation, Incubation and Linkages,
8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),
9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,
10. The Director of Board of Student Development,
11. The Director, Department of Students Welfare (DSD),
12. All Deputy Registrar, Examination House,
13. The Deputy Registrars, Finance & Accounts Section,
14. The Assistant Registrar, Administrative sub-Campus Thane,
15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,
16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,
17. The Assistant Registrar, Constituent Colleges Unit,
18. BUCTU,
19. The Receptionist,
20. The Telephone Operator,
21. The Secretary MUASA

for information.

UNIVERSITY OF MUMBAI



Bachelor of Engineering in Computer Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC: 29/06/2021

Item No: 6.15

UNIVERSITY OF MUMBAI



Sr. No.	Heading	Particulars
1	Title of the Course	Third Year Engineering (Computer Engineering)
2	Eligibility for Admission	After Passing Second Year Engineering as per the Ordinance 0.6243
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	Ordinance 0.6243
5	No. of Years / Semesters	8 semesters
6	Level	P.G. / U.G./~~Diploma~~ / Certificate (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / Semester (Strike out which is not applicable)
8	Status	~~New~~ / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	With effect from Academic Year: 2021-2022

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2021-22. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2022-23, 2023-24, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

ncorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface by Board of Studies in Computer Engineering

Dear Students and Teachers, we, the members of Board of Studies Computer Engineering, are very happy to present Third Year Computer Engineering syllabus effective from the Academic Year 2021-22 (REV-2019'C' Scheme). We are sure you will find this syllabus interesting, challenging, fulfill certain needs and expectations.

Computer Engineering is one of the most sought-after courses amongst engineering students. The syllabus needs revision in terms of preparing the student for the professional scenario relevant and suitable to cater the needs of industry in present day context. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. It is intended to provide a modern, industry-oriented education in Computer Engineering. It aims at producing trained professionals who can successfully acquainted with the demands of the industry worldwide. They obtain skills and experience in up-to-date the knowledge to analysis, design, implementation, validation, and documentation of computer software and systems.

The revised syllabus is finalized through a brain storming session attended by Heads of Departments or senior faculty from the Department of Computer Engineering of the affiliated Institutes of the Mumbai University. The syllabus falls in line with the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of the revised syllabus are:

1. Reduction in credits to 170 is implemented to ensure that students have more time for extracurricular activities, innovations, and research.
2. The department Optional Courses will provide the relevant specialization within the branch to a student.
3. Introduction of Skill Based Lab and Mini Project to showcase their talent by doing innovative projects that strengthen their profile and increases the chance of employability.
4. Students are encouraged to take up part of course through MOOCs platform SWAYAM

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Board of Studies in Computer Engineering

Prof. Sunil Bhirud	: Chairman
Prof. Sunita Patil	: Member
Prof. Leena Raga	: Member
Prof. Subhash Shinde	: Member
Prof. Meera Narvekar	: Member
Prof. Suprtim Biswas	: Member
Prof. Sudhir Sawarkar	: Member
Prof. Dayanand Ingle	: Member
Prof. Satish Ket	: Member

Program Structure for Third Year Computer Engineering
UNIVERSITY OF MUMBAI (With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract.		Theory	Pract.	Tuto	Total	
CSC501	Theoretical Computer Science	3	--		3	--	1	4	
CSC502	Software Engineering	3	--		3	--	--	3	
CSC503	Computer Network	3	--		3	--	--	3	
CSC504	Data Warehousing & Mining	3	--		3	--	--	3	
CSDLO501x	Department Level Optional Course- 1	3	--		3	--	--	3	
CSL501	Software Engineering Lab	--	2		--	1	--	1	
CSL502	Computer Network Lab	--	2		--	1	--	1	
CSL503	Data Warehousing & Mining Lab	--	2		--	1	--	1	
CSL504	Professional Comm. & Ethics II	--	2*+2		--	2	--	2	
CSM501	Mini Project: 2 A	--	4 ^{\$}		--	2	--	2	
Total		15	14		15	07	01	23	
Course Code	Course Name		Examination Scheme						
			Theory				Term Work	Pract &oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
CSC501	Theoretical Computer Science	20	20	20	80	3	25	--	125
CSC502	Software Engineering	20	20	20	80	3	--	--	100
CSC503	Computer Network	20	20	20	80	3	--	--	100
CSC504	Data Warehousing & Mining	20	20	20	80	3	--	--	100
CSDLO501x	Department Level Optional Course -1	20	20	20	80	3	--	--	100
CSL501	Software Engineering Lab	--	--	--	--	--	25	25	50
CSL502	Computer Network Lab	--	--	--	--	--	25	25	50
CSL503	Data Warehousing & Mining Lab	--	--	--	--	--	25	25	50
CSL504	Professional Comm. & Ethics II	--	--	--	--	--	25	25	50
CSM501	Mini Project : 2A	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	150	125	775

* Theory class to be conducted for full class and \$ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

**Program Structure for Third Year Computer Engineering
UNIVERSITY OF MUMBAI (With Effect from 2021-2022)**

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned				
		Theory	Pract. Tut.		Theory	Pract.	Total		
CSC601	System Programming & Compiler Construction	3	--		3	--	3		
CSC602	Cryptography & System Security	3	--		3		3		
CSC603	Mobile Computing	3	--		3	--	3		
CSC604	Artificial Intelligence	3	--		3	--	3		
CSDLO601x	Department Level Optional Course -2	3	--		3	--	3		
CSL601	System Programming & Compiler Construction Lab	--	2		--	1	1		
CSL602	Cryptography & System Security Lab	--	2		--	1	1		
CSL603	Mobile Computing Lab	--	2		--	1	1		
CSL604	Artificial Intelligence Lab	--	2		--	1	1		
CSL605	Skill base Lab Course: Cloud Computing	--	4		--	2	2		
CSM601	Mini Project Lab: 2B	--	4 ^s		--	2	2		
Total		15	16		15	08	23		
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
CSC601	System Programming & Compiler Construction	20	20	20	80	3	--	--	100
CSC602	Cryptography & System Security	20	20	20	80	3	--	--	100
CSC603	Mobile Computing	20	20	20	80	3	--	--	100
CSC604	Artificial Intelligence	20	20	20	80	3	--	--	100
CSDLO601x	Department Level Optional Course -2	20	20	20	80	3	--	--	100
CSL601	System Programming & Compiler Construction Lab	--	--	--	--	--	25	25	50
CSL602	Cryptography & System Security Lab	--	--	--	--	--	25	--	25
CSL603	Mobile Computing Lab	--	--	--	--	--	25	-	25
CSL604	Artificial Intelligence Lab						25	25	50
CSL605	Skill base Lab Course: Cloud Computing	--	--	--	--	--	50	25	75
CSM601	Mini Project :2B	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	175	100	775

Program Structure for Computer Engineering
UNIVERSITY OF MUMBAI (With Effect from 2021-2022)

Department Optional Courses

Department Level Optional Courses	Semester	Code & Course
Department Level Optional Course -1	V	CSDLO5011: Probabilistic Graphical Models CSDLO5012: Internet Programming CSDLO5013: Advance Database Management System
Department Level Optional Course -2	VI	CSDLO6011: Internet of Things CSDLO6012: Digital Signal & Image Processing CSDLO6013: Quantitative Analysis

Course Code	Course Name	Credits
CSC501	Theoretical Computer Science	3

Prerequisite: Discrete Structures

Course Objectives:

1. Acquire conceptual understanding of fundamentals of grammars and languages.
2. Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata.
3. Develop understanding of different types of Turing machines and applications.
4. Understand the concept of Undecidability.

Course Outcomes: At the end of the course, the students will be able to

1. Understand concepts of Theoretical Computer Science, difference and equivalence of DFA and NFA, languages described by finite automata and regular expressions.
2. Design Context free grammar, pushdown automata to recognize the language.
3. Develop an understanding of computation through Turing Machine.
4. Acquire fundamental understanding of decidability and undecidability.

Module No.	Unit No.	Topics	Theory Hrs.
1.0		Basic Concepts and Finite Automata	09
	1.1	Importance of TCS, Alphabets, Strings, Languages, Closure properties, Finite Automata (FA) and Finite State machine (FSM).	
	1.2	Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers, Equivalence between NFA with and without ϵ -transitions, NFA to DFA Conversion, Minimization of DFA, FSM with output: Moore and Mealy machines, Applications and limitations of FA.	
2.0		Regular Expressions and Languages	07
	2.1	Regular Expression (RE), Equivalence of RE and FA, Arden's Theorem, RE Applications	
	2.2	Regular Language (RL), Closure properties of RLs, Decision properties of RLs, Pumping lemma for RLs.	
3.0		Grammars	08
	3.1	Grammars and Chomsky hierarchy	
	3.2	Regular Grammar (RG), Equivalence of Left and Right linear grammar, Equivalence of RG and FA.	

	3.3	Context Free Grammars (CFG) Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity, Simplification and Applications, Normal Forms: Chomsky Normal Forms (CNF) and Greibach Normal Forms (GNF), Context Free language (CFL) - Pumping lemma, Closure properties.	
4.0		Pushdown Automata(PDA)	04
	4.1	Definition, Language of PDA,PDA as generator, decider and acceptor of CFG, Deterministic PDA , Non-Deterministic PDA, Application of PDA.	
5.0		Turing Machine (TM)	09
	5.1	Definition, Design of TM as generator, decider and acceptor, Variants of TM: Multitrack, Multitape, Universal TM, Applications, Power and Limitations of TMs.	
6.0		Undecidability	02
	6.1	Decidability and Undecidability, Recursive and Recursively Enumerable Languages, Halting Problem, Rice's Theorem, Post Correspondence Problem.	
Total			39

Text Books:	
1.	John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, <i>“Introduction to Automata Theory, Languages and Computation”</i> , 3 rd Edition, Pearson Education, 2008.
2.	Michael Sipser, <i>“Theory of Computation”</i> , 3 rd Edition, Cengage learning. 2013.
3.	Vivek Kulkarni, <i>“Theory of Computation”</i> , Illustrated Edition, Oxford University Press, (12 April 2013) India.
Reference Books:	
1.	J. C. Martin, <i>“Introduction to Languages and the Theory of Computation”</i> , 4 th Edition, Tata McGraw Hill Publication, 2013.
2.	Kavi Mahesh, <i>“Theory of Computation: A Problem Solving Approach”</i> , Kindle Edition, Wiley-India, 2011.

Assessment:	
Internal Assessment:	
1.	Assessment consists of two class tests of 20 marks each.
2.	The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed.
3.	Duration of each test shall be one hour.
Term work:	
1.	Term Work should consist of at least 06 assignments (at least one assignment on each module).

2.	Assignment (best 5 assignments)	20 marks
	Attendance	5 marks
3.	It is recommended to use JFLAP software (www.jflap.org) for better teaching and learning processes.	

End Semester Theory Examination:	
1.	Question paper will comprise of 6 questions, each carrying 20 marks.
2.	The students need to solve total 4 questions.
3.	Question No.1 will be compulsory and based on entire syllabus.
4.	Remaining questions (Q.2 to Q.6) will cover all the modules of syllabus.
Useful Links:	
1.	www.jflap.org
2.	https://nptel.ac.in/courses/106/104/106104028/
3.	https://nptel.ac.in/courses/106/104/106104148/

Course Code:	Course Title	Credit
CSC502	Software Engineering	3

Prerequisite: Object Oriented Programming with Java , Python Programming

Course Objectives:

- 1 To provide the knowledge of software engineering discipline.
- 2 To apply analysis, design and testing principles to software project development.
- 3 To demonstrate and evaluate real world software projects.

Course Outcomes: On successful completion of course, learners will be able to:

- 1 Identify requirements & assess the process models.
- 2 Plan, schedule and track the progress of the projects.
- 3 Design the software projects.
- 4 Do testing of software project.
- 5 Identify risks, manage the change to assure quality in software projects.

Module		Content	Hrs
1		Introduction To Software Engineering and Process Models	7
	1.1	Software Engineering-process framework, the Capability Maturity Model (CMM), Advanced Trends in Software Engineering	
	1.2	Prescriptive Process Models: The Waterfall, Incremental Process Models, Evolutionary Process Models: RAD & Spiral	
	1.3	Agile process model: Extreme Programming (XP), Scrum, Kanban	
2		Software Requirements Analysis and Modeling	4
	2.1	Requirement Engineering, Requirement Modeling, Data flow diagram, Scenario based model	
	2.2	Software Requirement Specification document format(IEEE)	
3		Software Estimation Metrics	7
	3.1	Software Metrics, Software Project Estimation (LOC, FP, COCOMO II)	
	3.2	Project Scheduling & Tracking	
4		Software Design	7
	4.1	Design Principles & Concepts	
	4.2	Effective Modular Design, Cohesion and Coupling, Architectural design	
5		Software Testing	7
	5.1	Unit testing, Integration testing, Validation testing, System testing	
	5.2	Testing Techniques, white-box testing: Basis path, Control structure testing black-box testing: Graph based, Equivalence, Boundary Value	
	5.3	Types of Software Maintenance, Re-Engineering, Reverse Engineering	
6		Software Configuration Management, Quality Assurance and Maintenance	7
	6.1	Risk Analysis & Management: Risk Mitigation, Monitoring and Management Plan (RMMM).	
	6.2	Quality Concepts and Software Quality assurance Metrics, Formal Technical Reviews, Software Reliability	
	6.3	The Software Configuration Management (SCM) ,Version Control and Change Control	
			39

Textbooks:	
1	Roger Pressman, " <i>Software Engineering: A Practitioner's Approach</i> ", 9 th edition , McGraw-Hill Publications, 2019
2	Ian Sommerville, " <i>Software Engineering</i> ", 9 th edition, Pearson Education, 2011
3	Ali Behfroz and Fredeick J. Hudson, " <i>Software Engineering Fundamentals</i> ", Oxford University Press, 1997
4	Grady Booch, James Rumbaugh, Ivar Jacobson, " <i>The unified modeling language user guide</i> ", 2 nd edition, Pearson Education, 2005
References:	
1	Pankaj Jalote, " <i>An integrated approach to Software Engineering</i> ", 3 rd edition, Springer, 2005
2	Rajib Mall, " <i>Fundamentals of Software Engineering</i> ", 5 th edition, Prentice Hall India, 2014
3	Jibitesh Mishra and Ashok Mohanty, " <i>Software Engineering</i> ", Pearson , 2011
4	Ugrasen Suman, " <i>Software Engineering – Concepts and Practices</i> ", Cengage Learning, 2013
5	Waman S Jawadekar, " <i>Software Engineering principles and practice</i> ", McGraw Hill Education, 2004

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and the second-class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Only Four questions need to be solved.
4	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105182/
2	https://onlinecourses.nptel.ac.in/noc19_cs69/preview
3	https://www.mooc-list.com/course/software-engineering-introduction-edx

Course Code:	Course Title	Credit
CSC503	Computer Network	3

Prerequisite: None

Course Objectives:

- 1 To introduce concepts and fundamentals of data communication and computer networks.
- 2 To explore the inter-working of various layers of OSI.
- 3 To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
- 4 To assess the strengths and weaknesses of various routing algorithms.
- 5 To understand various transport layer and application layer protocols.

Course Outcomes: On successful completion of course, learner will be able to

- 1 Demonstrate the concepts of data communication at physical layer and compare ISO - OSI model with TCP/IP model.
- 2 Explore different design issues at data link layer.
- 3 Design the network using IP addressing and sub netting / supernetting schemes.
- 4 Analyze transport layer protocols and congestion control algorithms.
- 5 Explore protocols at application layer

Module		Content	Hrs
1		Introduction to Networking	4
	1.1	Introduction to computer network, network application, network software and hardware components (Interconnection networking devices), Network topology, protocol hierarchies, design issues for the layers, connection oriented and connectionless services	
	1.2	Reference models: Layer details of OSI, TCP/IP models. Communication between layers.	
2		Physical Layer	3
	2.1	Introduction to Communication Electromagnetic Spectrum	
	2.2	Guided Transmission Media: Twisted pair, Coaxial, Fiber optics.	
3		Data Link Layer	8
	3.1	DLL Design Issues (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code, CRC, Checksum) , Elementary Data Link protocols , Stop and Wait, Sliding Window(Go Back N, Selective Repeat)	
	3.2	Medium Access Control sublayer Channel Allocation problem, Multiple access Protocol(Aloha, Carrier Sense Multiple Access (CSMA/CD)	
4		Network layer	12
	4.1	Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. IPv4 Addressing (classfull and classless), Subnetting, Supernetting design problems ,IPv4 Protocol, Network Address Translation (NAT), IPv6	
	4.2	Routing algorithms : Shortest Path (Dijkstra's), Link state routing, Distance Vector Routing	
	4.3	Protocols - ARP,RARP, ICMP, IGMP	

	4.4	Congestion control algorithms: Open loop congestion control, Closed loop congestion control, QoS parameters, Token & Leaky bucket algorithms	
5		Transport Layer	6
	5.1	The Transport Service: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers	
	5.2	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start	
6		Application Layer	6
	6.1	DNS: Name Space, Resource Record and Types of Name Server. HTTP, SMTP, Telnet, FTP, DHCP	

Textbooks:	
1	A.S. Tanenbaum, Computer Networks , 4 th edition Pearson Education
2	B.A. Forouzan, Data Communications and Networking , 5 th edition, TMH
3	James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet , 6 th edition, Addison Wesley
References:	
1	S.Keshav, An Engineering Approach To Computer Networking , Pearson
2	Natalia Olifer & Victor Olifer, Computer Networks: Principles, Technologies & Protocols for Network Design , Wiley India, 2011.
3	Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach , Second Edition, The Morgan Kaufmann Series in Networking

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://www.netacad.com/courses/networking/networking-essentials
2	https://www.coursera.org/learn/computer-networking
3	https://nptel.ac.in/courses/106/105/106105081
4	https://www.edx.org/course/introduction-to-networking

Course Code:	Course Title	Credit
CSC504	Data Warehousing and Mining	3

Prerequisite: Database Concepts	
Course Objectives:	
1.	To identify the significance of Data Warehousing and Mining.
2.	To analyze data, choose relevant models and algorithms for respective applications.
3.	To study web data mining.
4.	To develop research interest towards advances in data mining.
Course Outcomes: At the end of the course, the student will be able to	
1.	Understand data warehouse fundamentals and design data warehouse with dimensional modelling and apply OLAP operations.
2.	Understand data mining principles and perform Data preprocessing and Visualization.
3.	Identify appropriate data mining algorithms to solve real world problems.
4.	Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining
5.	Describe complex information and social networks with respect to web mining.

Module	Content	Hrs
1	Data Warehousing Fundamentals	8
	Introduction to Data Warehouse, Data warehouse architecture, Data warehouse versus Data Marts, E-R Modeling versus Dimensional Modeling, Information Package Diagram, Data Warehouse Schemas; Star Schema, Snowflake Schema, Factless Fact Table, Fact Constellation Schema. Update to the dimension tables. Major steps in ETL process, OLTP versus OLAP, OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot.	
2	Introduction to Data Mining, Data Exploration and Data Pre-processing	8
	Data Mining Task Primitives, Architecture, KDD process, Issues in Data Mining, Applications of Data Mining, Data Exploration: Types of Attributes, Statistical Description of Data, Data Visualization, Data Preprocessing: Descriptive data summarization, Cleaning, Integration & transformation, Data reduction, Data Discretization and Concept hierarchy generation.	
3	Classification	6
	Basic Concepts, Decision Tree Induction, Naïve Bayesian Classification, Accuracy and Error measures, Evaluating the Accuracy of a Classifier: Holdout & Random Subsampling, Cross Validation, Bootstrap.	
4	Clustering	6
	Types of data in Cluster analysis, Partitioning Methods (<i>k</i> -Means, <i>k</i> -Medoids), Hierarchical Methods (Agglomerative, Divisive).	
5	Mining frequent patterns and associations	6
	Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining, Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori, Mining Frequent Itemsets without candidate generation, Introduction to Mining Multilevel Association Rules and Mining Multidimensional Association Rules.	

6	Web Mining	5
	Introduction, Web Content Mining: Crawlers, Harvest System, Virtual Web View, Personalization, Web Structure Mining: Page Rank, Clever, Web Usage Mining.	

Textbooks:

1	Paulraj Ponniah, “ <i>Data Warehousing: Fundamentals for IT Professionals</i> ”, Wiley India.
2	Han, Kamber, “ <i>Data Mining Concepts and Techniques</i> ”, Morgan Kaufmann 2 nd edition.
3	M.H. Dunham, “ <i>Data Mining Introductory and Advanced Topics</i> ”, Pearson Education.

References:

1	Reema Theraja, “ <i>Data warehousing</i> ”, Oxford University Press 2009.
2	Pang-Ning Tan, Michael Steinbach and Vipin Kumar, “ <i>Introduction to Data Mining</i> ”, Pearson Publisher 2 nd edition.
3	Ian H. Witten, Eibe Frank and Mark A. Hall, “ <i>Data Mining</i> ”, Morgan Kaufmann 3 rd edition.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example, If Q.2 part (a) from module 3 then part (b) can be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Useful Links

1	https://onlinecourses.nptel.ac.in/noc20_cs12/preview
2	https://www.coursera.org/specializations/data-mining

Course Code:	Course Title	Credit
CSDLO5011	Probabilistic Graphical Models	3

Prerequisite: Engineering Mathematics, Discrete Structure	
Course Objectives:	
1	To give comprehensive introduction of probabilistic graphical models
2	To make inferences, learning, actions and decisions while applying these models
3	To introduce real-world trade-offs when using probabilistic graphical models in practice
4	To develop the knowledge and skills necessary to apply these models to solve real world problems.
Course Outcomes: At the end of the course, the student will be able to	
1	Understand basic concepts of probabilistic graphical modelling.
2	Model and extract inference from various graphical models like Bayesian Networks, Markov Models
3	Perform learning and take actions and decisions using probabilistic graphical models
4	Represent real world problems using graphical models; design inference algorithms; and learn the structure of the graphical model from data.
5	Design real life applications using probabilistic graphical models.

Module		Content	Hrs
1.		Introduction to Probabilistic Graphical Modeling	5
	1.1	Introduction to Probability Theory: Probability Theory, Basic Concepts in Probability, Random Variables and Joint Distribution, Independence and Conditional Independence, Continuous Spaces, Expectation and Variances	
	1.2	Introduction to Graphs: Nodes and Edges, Subgraphs, Paths and Trails, Cycles and Loops	
	1.3	Introduction to Probabilistic Graph Models: Bayesian Network, Markov Model, Hidden Markov Model	
	1.4	Applications of PGM	
2.		Bayesian Network Model and Inference	10
	2.1	Directed Graph Model: Bayesian Network-Exploiting Independence Properties, Naive Bayes Model, Bayesian Network Model, Reasoning Patterns, Basic Independencies in Bayesian Networks, Bayesian Network Semantics, Graphs and Distributions. Modelling: Picking variables, Picking Structure, Picking Probabilities, D-separation	
	2.2	Local Probabilistic Models: Tabular CPDs, Deterministic CPDs, Context Specific CPDs, Generalized Linear Models.	

	2.3	Exact inference variable elimination: Analysis of Complexity, Variable Elimination, Conditioning, Inference with Structured CPDs.	
3.		Markov Network Model and Inference	8
	3.1	Undirected Graph Model : Markov Model-Markov Network, Parameterization of Markov Network, Gibb's distribution, Reduced Markov Network, Markov Network Independencies, From Distributions to Graphs, Fine Grained Parameterization, Over Parameterization	
	3.2	Exact inference variable elimination: Graph Theoretic Analysis for Variable Elimination, Conditioning	
4.		Hidden Markov Model and Inference	6
	4.1	Template Based Graph Model : HMM- Temporal Models, Template Variables and Template Factors, Directed Probabilistic Models, Undirected Representation, Structural Uncertainty.	
5.		Learning and Taking Actions and Decisions	6
	5.1	Learning Graphical Models: Goals of Learning, Density Estimation, Specific Prediction Tasks, Knowledge Discovery. Learning as Optimization: Empirical Risk, over fitting, Generalization, Evaluating Generalization Performance, Selecting a Learning Procedure, Goodness of fit, Learning Tasks. Parameter Estimation: Maximum Likelihood Estimation, MLE for Bayesian Networks	
	5.2	Causality: Conditioning and Intervention, Correlation and Causation, Causal Models, Structural Causal Identifiability, Mechanisms and Response Variables, Learning Causal Models. Utilities and Decisions: Maximizing Expected Utility, Utility Curves, Utility Elicitation. Structured Decision Problems: Decision Tree	
6.		Applications	4
	6.1	Application of Bayesian Networks: Classification, Forecasting, Decision Making	
	6.2	Application of Markov Models: Cost Effectiveness Analysis, Relational Markov Model and its Applications, Application in Portfolio Optimization	
	6.3	Application of HMM: Speech Recognition, Part of Speech Tagging, Bioinformatics.	

Textbooks:

1.	Daphne Koller and Nir Friedman, " Probabilistic Graphical Models: Principles and Techniques ", Cambridge, MA: The MIT Press, 2009 (ISBN 978-0-262-0139-2).
2.	David Barber, " Bayesian Reasoning and Machine Learning ", Cambridge University Press, 1 st edition, 2011.

References:

1.	Finn Jensen and Thomas Nielsen, " Bayesian Networks and Decision Graphs (Information Science and Statistics) ", 2nd Edition, Springer, 2007.
2.	Kevin P. Murphy, " Machine Learning: A Probabilistic Perspective ", MIT Press, 2012.
3.	Martin Wainwright and Michael Jordan, M., " Graphical Models, Exponential Families, and Variational Inference ", 2008.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1.	Question paper will comprise of total six questions.
2.	All question carries equal marks
3.	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4.	Only Four question need to be solved.
5.	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links

1.	https://www.coursera.org/specializations/probabilistic-graphical-models
2.	https://www.mooc-list.com/tags/probabilistic-graphical-models
3.	https://scholarship.claremont.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=2690&context=cmc_theses
4.	https://www.upgrad.com/blog/bayesian-networks/
5.	https://www.utas.edu.au/_data/assets/pdf_file/0009/588474/TR_14_BNs_a_resource_guide.pdf
6.	https://math.libretexts.org/Bookshelves/Applied_Mathematics/Book%3A_Applied_Finite_Mathematics_(Sekhon_and_Bloom)/10%3A_Markov_Chains/10.02%3A_Applications_of_Markov_Chains/10.2.01%3A_Applications_of_Markov_Chains_(Exercises)
7.	https://link.springer.com/chapter/10.1007/978-3-319-43742-2_24
8.	https://homes.cs.washington.edu/~pedrod/papers/kdd02a.pdf
9.	https://core.ac.uk/download/pdf/191938826.pdf
10.	https://cs.brown.edu/research/pubs/theses/ugrad/2005/dbooksta.pdf

11.	https://web.ece.ucsb.edu/Faculty/Rabiner/ece259/Reprints/tutorial%20on%20hmm%20and%20applications.pdf
12.	https://mi.eng.cam.ac.uk/~mjfg/mjfg_NOW.pdf
13.	http://bioinfo.au.tsinghua.edu.cn/member/jgu/pgm/materials/Chapter3-LocalProbabilisticModels.pdf

Suggested List of Experiments:	
Sr. No	Experiment
1.	Experiment on Probability Theory
2.	Experiment on Graph Theory
3.	Experiment on Bayesian Network Modelling
4.	Experiment on Markov Chain Modeling
5.	Experiment on HMM
6.	Experiment on Maximum Likelihood Estimation
7.	Decision Making using Decision Trees
8.	Learning with Optimization
** Suggestion: Laboratory work based on above syllabus can be incorporated along with mini project in CSM501: Mini-Project.	

Course Code:	Course Title	Credit
CSDLO5012	Internet Programming	3

Prerequisite: Data Structures, Programming Languages- JAVA, Python

Course Objectives:

1	To get familiar with the basics of Internet Programming.
2	To acquire knowledge and skills for creation of web site considering both client and server-side programming
3	To gain ability to develop responsive web applications and explore different web extensions and web services standards
4	To learn characteristics of RIA and React Js

Course Outcomes:

1	Implement interactive web page(s) using HTML and CSS.
2	Design a responsive web site using JavaScript and demonstrate database connectivity using JDBC
3	Demonstrate Rich Internet Application using Ajax and demonstrate and differentiate various Web Extensions
4	Demonstrate web application using Reactive Js

Module		Content	Hrs
1		Introduction to Web Technology	10
	1.1	Web Essentials: Clients, Servers and Communication, The Internet, Basic Internet protocols, World wide web, HTTP Request Message, HTTP Response Message, Web Clients, Web Servers HTML5 – fundamental syntax and semantics, Tables, Lists, Image, HTML5 control elements, Semantic elements, Drag and Drop, Audio – Video controls CSS3 – Inline, embedded and external style sheets – Rule cascading, Inheritance, Backgrounds, Border Images, Colors, Shadows, Text, Transformations, Transitions, Animation, Basics of Bootstrap.	
2		Front End Development	7
	2.1	Java Script: An introduction to JavaScript–JavaScript DOM Model–Date and Objects-Regular Expressions- Exception Handling-Validation-Built-in objects-Event Handling, DHTML with JavaScript–JSON introduction – Syntax – Function Files – Http Request –SQL.	
3.		Back End Development	7
	3.1	Servlets: Java Servlet Architecture, Servlet Life Cycle, Form GET and POST actions, Session Handling, Understanding Cookies, Installing and Configuring Apache Tomcat Web Server, Database Connectivity: JDBC perspectives, JDBC program example JSP: Understanding Java Server Pages, JSP Standard Tag Library (JSTL), Creating HTML forms by embedding JSP code.	
4		Rich Internet Application (RIA)	4
	4.1	Characteristics of RIA, Introduction to AJAX: AJAX design basics, AJAX vs Traditional Approach, Rich User Interface using Ajax, jQuery framework with AJAX.	
5		Web Extension: PHP and XML	6
	5.1	XML –DTD (Document Type Definition), XML Schema, Document Object Model, Presenting XML, Using XML Parsers: DOM and SAX, XSL-eXtensible Stylesheet Language	

	5.2	Introduction to PHP- Data types, control structures, built in functions, building web applications using PHP- tracking users, PHP and MySQL database connectivity with example.	
6		React js	5
	6.1	Introduction, React features, App “Hello World” Application, Introduction to JSX, Simple Application using JSX.	
			39

Textbooks:

1	Ralph Moseley, M.T. Savliya, “Developing Web Applications”, Willy India, Second Edition, ISBN: 978-81-265-3867-6
2	“Web Technology Black Book”, Dremtech Press, First Edition, 978-7722-997
3	Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, O'REILLY, 2014. (http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascript_CSS_HTML5__Robin_Nixon_3e.pdf)
4	Dana Moore, Raymond Budd, Edward Benson, Professional Rich Internet Applications: AJAX and Beyond Wiley publications. https://ebooks-it.org/0470082801-ebook.htm
5.	Alex Banks and Eve Porcello, Learning React Functional Web Development with React and Redux, O'REILLY, First Edition

References:

1	Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, Internet and World Wide Web - How To Program, Fifth Edition, Pearson Education, 2011.
2	Achyut S Godbole and Atul Kahate, —Web Technologies, Second Edition, Tata McGraw Hill, 2012.
3	Thomas A Powell, Fritz Schneider, —JavaScript: The Complete Reference, Third Edition, Tata McGraw Hill, 2013
4	David Flanagan, —JavaScript: The Definitive Guide, Sixth Edition, O'Reilly Media, 2011
5	Steven Holzner —The Complete Reference - PHP, Tata McGraw Hill, 2008
6	Mike Mcgrath—PHP & MySQL in easy Steps, Tata McGraw Hill, 2012.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links

1	https://books.goalkicker.com/ReactJSBook/
2	https://www.guru99.com/reactjs-tutorial.html
3	www.nptelvideos.in
4	www.w3schools.com
5	https://spoken-tutorial.org/
6	www.coursera.org

The following list can be used as a guideline for mini project:

1	Create Simple web page using HTML5
2	Design and Implement web page using CSS3 and HTML5
3	Form Design and Client-Side Validation using: a. Javascript and HTML5, b. Javascript and JQuery
4	Develop interactive web pages using HTML 5 with JDBC database connectivity
5	Develop simple web page using PHP
6	Develop interactive web pages using PHP with database connectivity MYSQL
7	Develop XML web page using DTD, XSL
8	Implement a web page using Ajax and PHP
9	Case study based on Reactive js
10	Installation of the React DOM library.
* Suggestion: Laboratory work based on above syllabus can be incorporated as mini project in CSM501: Mini-Project.	

Course Code:	Course Title	Credit
CSDLO5013	Advance Database Management System	3

Prerequisite: Database Management System

Course Objectives:

1	To provide insights into distributed database designing
2	To specify the various approaches used for using XML and JSON technologies.
3	To apply the concepts behind the various types of NoSQL databases and utilize it for MongoDB
4	To learn about the trends in advance databases

Course Outcomes: After the successful completion of this course learner will be able to:

1	Design distributed database using the various techniques for query processing
2	Measure query cost and perform distributed transaction management
3	Organize the data using XML and JSON database for better interoperability
4	Compare different types of NoSQL databases
5	Formulate NoSQL queries using MongoDB
6	Describe various trends in advance databases through temporal, graph based and spatial based databases

Module		Content	Hrs
1		Distributed Databases	3
	1.1	Introduction, Distributed DBMS Architecture, Data Fragmentation, Replication and Allocation Techniques for Distributed Database Design.	
2		Distributed Database Handling	8
	2.1	Distributed Transaction Management – Definition, properties, types, architecture Distributed Query Processing - Characterization of Query Processors, Layers/ phases of query processing.	
	2.2	Distributed Concurrency Control- Taxonomy, Locking based, Basic TO algorithm, Recovery in Distributed Databases: Failures in distributed database, 2PC and 3PC protocol.	
3		Data interoperability – XML and JSON	6
	3.1	XML Databases: Document Type Definition, XML Schema, Querying and Transformation: XPath and XQuery.	
	3.2	Basic JSON syntax, (Java Script Object Notation), JSON data types, Stringifying and parsing the JSON for sending & receiving, JSON Object retrieval using key-value pair and JQuery, XML Vs JSON	
4		NoSQL Distribution Model	10
	4.1	NoSQL database concepts: NoSQL data modeling, Benefits of NoSQL, comparison between SQL and NoSQL database system.	
	4.2	Replication and sharding, Distribution Models Consistency in distributed data, CAP theorem, Notion of ACID Vs BASE, handling Transactions, consistency and eventual consistency	
	4.3	Types of NoSQL databases: Key-value data store, Document database and Column Family Data store, Comparison of NoSQL databases w.r.t CAP theorem and ACID properties.	
5		NoSQL using MongoDB	6

	5.1	NoSQL using MongoDB: Introduction to MongoDB Shell, Running the MongoDB shell, MongoDB client, Basic operations with MongoDB shell, Basic Data Types, Arrays, Embedded Documents	
	5.2	Querying MongoDB using find() functions, advanced queries using logical operators and sorting, simple aggregate functions, saving and updating document. MongoDB Distributed environment: Concepts of replication and horizontal scaling through sharding in MongoDB	
6		Trends in advance databases	6
	6.1	Temporal database: Concepts, time representation, time dimension, incorporating time in relational databases.	
	6.2	Graph Database: Introduction, Features, Transactions, consistency, Availability, Querying, Case Study Neo4J	
	6.3	Spatial database: Introduction, data types, models, operators and queries	
			39

Textbooks:

1	Korth, Siberchatz, Sudarshan, "Database System Concepts", 6 th Edition, McGraw Hill
2	Elmasri and Navathe, "Fundamentals of Database Systems", 5 th Edition, Pearson Education
3	Ozsu, M. Tamer, Valduriez, Patrick, "Principles of distributed database systems", 3 rd Edition, Pearson Education, Inc.
4	Pramod Sadalge, Martin Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison Wesley/ Pearson
5	Jeff Friesen, Java XML and JSON, Second Edition, 2019, apress Inc.

References:

1	Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management, Thomson Learning, 5 th Edition.
2	Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3	Adam Fowler, NoSQL for dummies, John Wiley & Sons, Inc.
4	Shashank Tiwari, Professional NOSQL, John Willy & Sons. Inc
5	Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH
6	MongoDB Manual : https://docs.mongodb.com/manual

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

NOTE: Suggested that in Mini Projects (CSM501) can be included NoSQL databases for implementation as a backend.

Useful Links	
1	https://cassandra.apache.org
2	https://www.mongodb.com
3	https://riak.com
4	https://neo4j.com
5	https://martinfowler.com/articles/nosql-intro-original.pdf

Lab Code	Lab Name	Credit
CSL501	Software Engineering Lab	1

Prerequisite: Object Oriented Programming with Java , Python Programming

Lab Objectives:

1	To solve real life problems by applying software engineering principles
2	To impart state-of-the-art knowledge on Software Engineering

Lab Outcomes: On successful completion of laboratory experiments, learners will be able to :

1	Identify requirements and apply software process model to selected case study.
2	Develop architectural models for the selected case study.
3	Use computer-aided software engineering (CASE) tools.

Suggested List of Experiments - Assign the case study/project as detail statement of problem to a group of two/three students. Laboratory work will be based on course syllabus with minimum 10 experiments. Open source computer-aided software engineering (CASE) tools can be used for performing the experiment.

Sr. No.	Title of Experiment
1	Application of at least two traditional process models.
2	Application of the Agile process models.
3	Preparation of software requirement specification (SRS) document in IEEE format.
4	Structured data flow analysis.
5	Use of metrics to estimate the cost.
6	Scheduling & tracking of the project.
7	Write test cases for black box testing.
8	Write test cases for white box testing.
9	Preparation of Risk Mitigation, Monitoring and Management Plan (RMMM).
10	Version controlling of the project.

Term Work:

1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Software Engineering”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

Oral & Practical exam

Based on the entire syllabus of CSC502 and CSL501 syllabus

Lab Code	Lab Name	Credit
CSL502	Computer Network Lab	1

Prerequisite: None	
Lab Objectives:	
1	To practically explore OSI layers and understand the usage of simulation tools.
2	To analyze, specify and design the topological and routing strategies for an IP based networking infrastructure.
3	To identify the various issues of a packet transfer from source to destination, and how they are resolved by the various existing protocols
Lab Outcomes: On successful completion of lab, learner will be able to	
1	Design and setup networking environment in Linux.
2	Use Network tools and simulators such as NS2, Wireshark etc. to explore networking algorithms and protocols.
3	Implement programs using core programming APIs for understanding networking concepts.

Suggested List of Experiments	
Sr. No.	Title of Experiment
1.	Study of RJ45 and CAT6 Cabling and connection using crimping tool.
2.	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route)
3.	Build a simple network topology and configure it for static routing protocol using packet tracer. Setup a network and configure IP addressing, subnetting, masking.
4.	Perform network discovery using discovery tools (eg. Nmap, mrtg)
5.	Use Wire shark to understand the operation of TCP/IP layers: - Ethernet Layer: Frame header, Frame size etc. - Data Link Layer: MAC address, ARP (IP and MAC address binding) - Network Layer: IP Packet (header, fragmentation), ICMP (Query and Echo) - Transport Layer: TCP Ports, TCP handshake segments etc. - Application Layer: DHCP, FTP, HTTP header formats
6.	Use simulator (Eg. NS2) to understand functioning of ALOHA, CSMA/CD.
7.	Study and Installation of Network Simulator (NS3)
8.	a. Set up multiple IP addresses on a single LAN. b. Using nestat and route commands of Linux, do the following: - View current routing table - Add and delete routes - Change default gateway c. Perform packet filtering by enabling IP forwarding using IPtables in Linux.
9	Design VPN and Configure RIP/OSPF using Packet tracer.
10.	Socket programming using TCP or UDP
11.	Perform File Transfer and Access using FTP
12.	Perform Remote login using Telnet server

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Computer Network”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks,

	Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC503: Computer Network

Useful Links	
1	https://www.netacad.com/courses/packet-tracer/introduction-packet-tracer
2	https://www.coursera.org/projects/data-forwarding-computer-networks
3	https://www.edx.org/course/ilabx-the-internet-masterclass

Lab Code	Lab Name	Credit
CSL503	Data Warehousing and Mining Lab	1

Prerequisite: Database Concepts	
Lab Objectives:	
1.	Learn how to build a data warehouse and query it.
2.	Learn about the data sets and data preprocessing.
3.	Demonstrate the working of algorithms for data mining tasks such Classification, clustering, Association rule mining & Web mining
4.	Apply the data mining techniques with varied input values for different parameters.
5.	Explore open source software (like WEKA) to perform data mining tasks.
Lab Outcomes: At the end of the course, the student will be able to	
1.	Design data warehouse and perform various OLAP operations.
2.	Implement data mining algorithms like classification.
3.	Implement clustering algorithms on a given set of data sample.
4.	Implement Association rule mining & web mining algorithm.

Suggested List of Experiments	
Sr. No.	Title of Experiment
1	One case study on building Data warehouse/Data Mart Write Detailed Problem statement and design dimensional modelling (creation of star and snowflake schema)
2	Implementation of all dimension table and fact table based on experiment 1 case study
3	Implementation of OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot based on experiment 1 case study
4	Implementation of Bayesian algorithm
5	Implementation of Data Discretization (any one) & Visualization (any one)
6	Perform data Pre-processing task and demonstrate Classification, Clustering, Association algorithm on data sets using data mining tool (WEKA/R tool)
7	Implementation of Clustering algorithm (K-means/K-medoids)
8	Implementation of any one Hierarchical Clustering method
9	Implementation of Association Rule Mining algorithm (Apriori)
10	Implementation of Page rank/HITS algorithm

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 1 assignment on content of theory and practical of “Data Warehousing and Mining”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance (Theory & Practical): 05-marks, Assignments: 05-marks)
Oral & Practical exam	
	Based on the entire syllabus of CSC504 : Data Warehousing and Mining

Course Code	Course Name	Credit
CSL504	Professional Communication & Ethics II	02

Course Rationale: This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.

Course Objectives

1	To discern and develop an effective style of writing important technical/business documents.
2	To investigate possible resources and plan a successful job campaign.
3	To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4	To develop creative and impactful presentation skills.
5	To analyze personal traits, interests, values, aptitudes and skills.
6	To understand the importance of integrity and develop a personal code of ethics.

Course Outcomes: At the end of the course, the student will be able to

1	Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2	Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3	Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4	Deliver persuasive and professional presentations.
5	Develop creative thinking and interpersonal skills required for effective professional communication.
6	Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Module	Contents	Hours
1	ADVANCED TECHNICAL WRITING: PROJECT/PROBLEM BASED LEARNING (PBL)	06
	Purpose and Classification of Reports: Classification on the basis of: Subject Matter (Technology, Accounting, Finance, Marketing, etc.), Time Interval (Periodic, One-time, Special), Function (Informational, Analytical, etc.), Physical Factors (Memorandum, Letter, Short & Long) Parts of a Long Formal Report: Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter) Language and Style of Reports: Tense, Person & Voice of Reports, Numbering Style of Chapters, Sections, Figures, Tables and Equations, Referencing Styles in APA & MLA Format, Proofreading through Plagiarism Checkers Definition, Purpose & Types of Proposals: Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals) Parts of a Proposal: Elements, Scope and Limitations, Conclusion Technical Paper Writing: Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References), Language and Formatting, Referencing in IEEE Format	

2	EMPLOYMENT SKILLS	06
	Cover Letter & Resume: Parts and Content of a Cover Letter, Difference between Bio-data, Resume & CV, Essential Parts of a Resume, Types of Resume (Chronological, Functional & Combination) Statement of Purpose: Importance of SOP, Tips for Writing an Effective SOP Verbal Aptitude Test: Modelled on CAT, GRE, GMAT exams Group Discussions: Purpose of a GD, Parameters of Evaluating a GD, Types of GDs (Normal, Case-based & Role Plays), GD Etiquettes Personal Interviews: Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	
3	BUSINESS MEETINGS	02
	Conducting Business Meetings: Types of Meetings, Roles and Responsibilities of Chairperson, Secretary and Members, Meeting Etiquette Documentation: Notice, Agenda, Minutes	
4	TECHNICAL/ BUSINESS PRESENTATIONS	02
	Effective Presentation Strategies: Defining Purpose, Analyzing Audience, Location and Event, Gathering, Selecting & Arranging Material, structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation, Platform skills Group Presentations: Sharing Responsibility in a Team, Building the contents and visuals together, Transition Phases	
5	INTERPERSONAL SKILLS	08
	Interpersonal Skills: Emotional Intelligence, Leadership & Motivation, Conflict Management & Negotiation, Time Management, Assertiveness, Decision Making Start-up Skills: Financial Literacy, Risk Assessment, Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	
6	CORPORATE ETHICS	02
	Intellectual Property Rights: Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications, Integrated Circuits, Trade Secrets (Undisclosed Information) Case Studies: Cases related to Business/ Corporate Ethics	

List of assignments: (In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

Sr. No.	Title of Experiment
1	Cover Letter and Resume
2	Short Proposal
3	Meeting Documentation
4	Writing a Technical Paper/ Analyzing a Published Technical Paper
5	Writing a SOP
6	IPR
7	Interpersonal Skills
Note:	
1	The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).

2	The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3	There will be an end–semester presentation based on the book report.
Assessment:	
Term Work:	
1	Term work shall consist of minimum 8 experiments.
2	The distribution of marks for term work shall be as follows: Assignment : 10 Marks Attendance : 5 Marks Presentation slides : 5 Marks Book Report (hard copy) : 5 Marks
3	The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.
Internal oral: Oral Examination will be based on a GD & the Project/Book Report presentation.	
	Group Discussion : 10 marks Project Presentation : 10 Marks Group Dynamics : 5 Marks
Books Recommended: Textbooks and Reference books	
1	Arms, V. M. (2005). <i>Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition</i> . Boston, MA: McGraw-Hill.
2	Bovée, C. L., &Thill, J. V. (2021). <i>Business communication today</i> . Upper Saddle River, NJ: Pearson.
3	Butterfield, J. (2017). <i>Verbal communication: Soft skills for a digital workplace</i> . Boston, MA: Cengage Learning.
4	Masters, L. A., Wallace, H. R., & Harwood, L. (2011). <i>Personal development for life and work</i> . Mason: South-Western Cengage Learning.
5	Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). <i>Organizational behaviour</i> . Harlow, England: Pearson.
6	Meenakshi Raman, Sangeeta Sharma (2004) <i>Technical Communication, Principles and Practice</i> . Oxford University Press
7	Archana Ram (2018) <i>Place Mentor, Tests of Aptitude for Placement Readiness</i> . Oxford University Press
8	Sanjay Kumar &PushpLata (2018). <i>Communication Skills a workbook</i> , New Delhi: Oxford University Press.

Course Code	Course Name	Credits
CSM501	Mini Project 2A	02

Objectives	
1	To understand and identify the problem
2	To apply basic engineering fundamentals and attempt to find solutions to the problems.
3	Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
4	To develop communication skills and improve teamwork amongst group members and inculcate the process of self-learning and research.
Outcome: Learner will be able to...	
1	Identify societal/research/innovation/entrepreneurship problems through appropriate literature surveys
2	Identify Methodology for solving above problem and apply engineering knowledge and skills to solve it
3	Validate, Verify the results using test cases/benchmark data/theoretical/inferences/experiments/simulations
4	Analyze and evaluate the impact of solution/product/research/innovation /entrepreneurship towards societal/environmental/sustainable development
5	Use standard norms of engineering practices and project management principles during project work
6	Communicate through technical report writing and oral presentation. • The work may result in research/white paper/ article/blog writing and publication • The work may result in business plan for entrepreneurship product created • The work may result in patent filing.
7	Gain technical competency towards participation in Competitions, Hackathons, etc.
8	Demonstrate capabilities of self-learning, leading to lifelong learning.
9	Develop interpersonal skills to work as a member of a group or as leader
Guidelines for Mini Project	
1	Mini project may be carried out in one or more form of following: Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.
2	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
3	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor or head of department/internal committee of faculties.
4	Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
5	A logbook may be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
6	Faculty supervisors may give inputs to students during mini project activity; however, focus shall be on self-learning.
7	Students under the guidance of faculty supervisor shall convert the best solution into a working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of

	annexure to the report.
9	With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 2 in semesters V and VI.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

Term Work		
The review/ progress monitoring committee shall be constituted by the heads of departments of each institute. The progress of the mini project to be evaluated on a continuous basis, based on the SRS document submitted. minimum two reviews in each semester.		
In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.		
Distribution of Term work marks for both semesters shall be as below:		Marks 25
1	Marks awarded by guide/supervisor based on logbook	10
2	Marks awarded by review committee	10
3	Quality of Project report	05
Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines		
One-year project:		
1	In one-year project (sem V and VI), first semester the entire theoretical solution shall be made ready, including components/system selection and cost analysis. Two reviews will be conducted based on a presentation given by a student group. ☐ First shall be for finalization of problem ☐ Second shall be on finalization of proposed solution of problem.	
2	In the second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. ☐ First review is based on readiness of building working prototype to be conducted. ☐ Second review shall be based on poster presentation cum demonstration of working model in the last month of the said semester.	
Half-year project:		
1	In this case in one semester students' group shall complete project in all aspects including, ☐ Identification of need/problem ☐ Proposed final solution ☐ Procurement of components/systems ☐ Building prototype and testing	
2	Two reviews will be conducted for continuous assessment, ☐ First shall be for finalization of problem and proposed solution ☐ Second shall be for implementation and testing of solution.	

Mini Project shall be assessed based on following points	
1	Clarity of problem and quality of literature Survey for problem identification
2	Requirement Gathering via SRS/ Feasibility Study
3	Completeness of methodology implemented
4	Design, Analysis and Further Plan
5	Novelty, Originality or Innovativeness of project
6	Societal / Research impact
7	Effective use of skill set : Standard engineering practices and Project management standard
8	Contribution of an individual's as member or leader
9	Clarity in written and oral communication
10	Verification and validation of the solution/ Test Cases
11	Full functioning of working model as per stated requirements
12	Technical writing /competition/hackathon outcome being met

In one year project (sem V and VI), first semester evaluation may be based on first 10 criteria and remaining may be used for second semester evaluation of performance of students in mini projects.

In case of half year projects (completing in V sem) all criteria in generic may be considered for evaluation of performance of students in mini projects.

Guidelines for Assessment of Mini Project Practical/Oral Examination:	
1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by the head of Institution.
3	Students shall be motivated to publish a paper/participate in competition based on the work in Conferences/students competitions.

Course Code:	Course Title	Credit
CSC601	System Programming and Compiler Construction	3

Prerequisite: Theoretical computer science, Operating system. Computer Organization and Architecture .

Course Objectives:

1	To understand the role and functionality of various system programs over application programs.
2	To understand basic concepts, structure and design of assemblers, macro processors, linkers and loaders.
3	To understand the basic principles of compiler design, its various constituent parts, algorithms and data structures required to be used in the compiler.
4	To understand the need to follow the syntax in writing an application program and to learn how the analysis phase of compiler is designed to understand the programmer 's requirements without ambiguity
5	To synthesize the analysis phase outcomes to produce the object code that is efficient in terms of space and execution time

Course Outcomes: On successful completion of course, learner will be able to

1	Identify the relevance of different system programs.
2	Explain various data structures used for assembler and microprocessor design.
3	Distinguish between different loaders and linkers and their contribution in developing efficient user applications.
4	Understand fundamentals of compiler design and identify the relationships among different phases of the compiler.

Module		Content	Hrs
1		Introduction to System Software	2
	1.1	Concept of System Software, Goals of system software, system program and system programming, Introduction to various system programs such as Assembler, Macro processor, Loader, Linker, Compiler, Interpreter, Device Drivers, Operating system, Editors, Debuggers.	
2		Assemblers	7
	2.1	Elements of Assembly Language programming, Assembly scheme, pass structure of assembler, Assembler Design: Two pass assembler Design and single pass Assembler Design for X86 processor, data structures used.	
3		Macros and Macro Processor	6
	3.1	Introduction, Macro definition and call, Features of Macro facility: Simple, parameterized, conditional and nested. Design of Two pass macro processor, data structures used.	
4		Loaders and Linkers	6
	4.1	Introduction, functions of loaders, Relocation and Linking concept, Different loading schemes: Relocating loader, Direct Linking Loader, Dynamic linking and loading.	
5		Compilers: Analysis Phase	10
	5.1	Introduction to compilers, Phases of compilers: Lexical Analysis- Role of Finite State Automata in Lexical Analysis, Design of Lexical analyzer, data structures used.	

		Syntax Analysis - Role of Context Free Grammar in Syntax analysis, Types of Parsers: Top down parser- LL(1), Bottom up parser- SR Parser, Operator precedence parser, SLR. Semantic Analysis , Syntax directed definitions.	
6		Compilers: Synthesis phase	8
	6.1	Intermediate Code Generation : Types of Intermediate codes: Syntax tree, Postfix notation, three address codes: Triples and Quadruples, indirect triple. Code Optimization : Need and sources of optimization, Code optimization techniques: Machine Dependent and Machine Independent. Code Generation : Issues in the design of code generator, code generation algorithm. Basic block and flow graph.	

Textbooks:

1	D. M Dhamdhare: <i>Systems programming and Operating Systems</i> , Tata McGraw Hill, Revised Second Edition
2	A. V. Aho, R. Shethi, Monica Lam, J.D. Ulman: <i>Compilers Principles, Techniques and Tools</i> , Pearson Education, Second Edition.
3	J. J. Donovan: <i>Systems Programming</i> Tata McGraw Hill, Edition 1991

References:

1	John R. Levine, Tony Mason & Doug Brown, <i>Lex & YACC</i> , O 'Reilly publication, second Edition
2	D, M .Dhamdhare , <i>Compiler construction</i> 2e, Macmillan publication, second edition .
3	Kenneth C. Loudon , <i>Compiler construction: principles and practices</i> , Cengage Learning
4	Leland L. Beck, <i>System software: An introduction to system programming</i> , Pearson publication, Third Edition

Useful Links for E-resources:

1	http://www.nptelvideos.in/2012/11/compiler-design.html
2	https://www.coursera.org/lecture/nand2tetris2/unit-4-1-syntax-analysis-5pC2Z

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first -class test is to be conducted when approx. 40% syllabus is completed and the second-class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Course Code:	Course Title	Credit
CSC602	Cryptography & System Security	3

Prerequisite: Computer Networks	
Course Objectives:	
1	To introduce classical encryption techniques and concepts of modular arithmetic and number theory.
2	To explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms
3	To explore the design issues and working principles of various authentication protocols, PKI standards and various secure communication standards including Kerberos, IPsec, and SSL/TLS.
4	To develop the ability to use existing cryptographic utilities to build programs for secure communication
Course Outcomes:	
1	Understand system security goals and concepts, classical encryption techniques and acquire fundamental knowledge on the concepts of modular arithmetic and number theory
2	Understand, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication
3	Apply different message digest and digital signature algorithms to verify integrity and achieve authentication and design secure applications
4	Understand network security basics, analyse different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP
5	Analyse and apply system security concept to recognize malicious code

Module		Content	Hrs
1		Introduction - Number Theory and Basic Cryptography	8
	1.1	Security Goals, Attacks, Services and Mechanisms, Techniques. Modular Arithmetic: Euclidean Algorithm, Fermat's and Euler's theorem	
	1.2	Classical Encryption techniques, Symmetric cipher model, mono-alphabetic and polyalphabetic substitution techniques: Vigenere cipher, playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers	
2		Symmetric and Asymmetric key Cryptography and key Management	11
	2.1	Block cipher principles, block cipher modes of operation, DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Stream Ciphers: RC4 algorithm.	
	2.2	Public key cryptography: Principles of public key cryptosystems- The RSA Cryptosystem, The knapsack cryptosystem	
	2.3	Symmetric Key Distribution: KDC, Needham-schroeder protocol. Kerberos: Kerberos Authentication protocol, Symmetric key agreement: Diffie Hellman, Public key Distribution: Digital Certificate: X.509, PKI	
3		Cryptographic Hash Functions	3
	3.1	Cryptographic hash functions, Properties of secure hash function, MD5, SHA-1, MAC, HMAC, CMAC.	
4		Authentication Protocols & Digital Signature Schemes	5
	4.1	User Authentication, Entity Authentication: Password Base, Challenge Response Based	

	4.2	Digital Signature, Attacks on Digital Signature, Digital Signature Scheme: RSA	
5		Network Security and Applications	9
	5.1	Network security basics: TCP/IP vulnerabilities (Layer wise), Network Attacks: Packet Sniffing, ARP spoofing, port scanning, IP spoofing	
	5.2	Denial of Service: DOS attacks, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service	
	5.3	Internet Security Protocols: PGP, SSL, IPSEC. Network security: IDS, Firewalls	
6		System Security	3
	6.1	Buffer Overflow, malicious Programs: Worms and Viruses, SQL injection	

Textbooks:

1	William Stallings, “ <i>Cryptography and Network Security, Principles and Practice</i> ”, 6th Edition, Pearson Education, March 2013
2	Behrouz A. Ferouzan, “ <i>Cryptography & Network Security</i> ”, Tata McGraw Hill
3	Behrouz A. Forouzan & Debdeep Mukhopadhyay, “ <i>Cryptography and Network Security</i> ” 3rd Edition, McGraw Hill

Referecebooks:

1	Bruce Schneier, “ <i>Applied Cryptography, Protocols Algorithms and Source Code in C</i> ”, Second Edition, Wiley.
2	Atul Kahate, “ <i>Cryptography and Network Security</i> ”, Tata McGraw-Hill Education, 2003.
3	Eric Cole, “ <i>Network Security Bible</i> ”, Second Edition, Wiley, 2011.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links

1	https://github.com/cmin764/cmiN/blob/master/FII/L3/SI/book/W.Stallings%20-%20Cryptography%20and%20Network%20Security%206th%20ed.pdf
2	https://docs.google.com/file/d/0B5F6yMKYDUbrYXE4X1ZCUHpLNnc/view

Course Code:	Course Title	Credit
CSC603	Mobile Computing	3

Prerequisite: Computer Networks	
Course Objectives:	
1	To introduce the basic concepts and principles in mobile computing. This includes major techniques involved, and networks & systems issues for the design and implementation of mobile computing systems and applications.
2	To explore both theoretical and practical issues of mobile computing.
3	To provide an opportunity for students to understand the key components and technologies involved and to gain hands-on experiences in building mobile applications.
Course Outcomes: On successful completion of course, learner will be able to	
1	To identify basic concepts and principles in computing, cellular architecture.
2	To describe the components and functioning of mobile networking.
3	To classify variety of security techniques in mobile network.
4	To apply the concepts of WLAN for local as well as remote applications.
5	To describe Long Term Evolution (LTE) architecture and its interfaces.

Module		Content	Hrs
1		Introduction to Mobile Computing	4
	1.1	Introduction to Mobile Computing, Telecommunication Generations, Cellular systems,	
	1.2	Electromagnetic Spectrum, Antenna, Signal Propagation, Signal Characteristics, Multiplexing, Spread Spectrum: DSSS & FHSS, Co-channel interference	
2		GSM Mobile services	8
	2.1	GSM Mobile services, System Architecture, Radio interface, Protocols, Localization and Calling, Handover, security (A3, A5 & A8)	
	2.2	GPRS system and protocol architecture	
	2.3	UTRAN, UMTS core network; Improvements on Core Network,	
3		Mobile Networking	8
	3.1	Medium Access Protocol, Internet Protocol and Transport layer	
	3.2	Mobile IP: IP Packet Delivery, Agent Advertisement and Discovery, Registration, Tunneling and Encapsulation, Reverse Tunneling.	
	3.3	Mobile TCP: Traditional TCP, Classical TCP Improvements like Indirect TCP, Snooping TCP & Mobile TCP, Fast Retransmit/ Fast Recovery, Transmission/Timeout Freezing, Selective Retransmission	
4		Wireless Local Area Networks	6
	4.1	Wireless Local Area Networks: Introduction, Infrastructure and ad-hoc network	
	4.2	IEEE 802.11: System architecture , Protocol architecture , Physical layer, Medium access control layer, MAC management, 802.11a, 802.11b standard	
	4.3	Wi-Fi security : WEP ,WPA, Wireless LAN Threats , Securing Wireless Networks	

	4.4	Bluetooth: Introduction, User Scenario, Architecture, protocol stack	
5		Mobility Management	6
	5.1	Mobility Management : Introduction, IP Mobility, Optimization, IPv6	
	5.2	Macro Mobility : MIPv6, FMIPv6	
	5.3	Micro Mobility: CellularIP, HAWAII, HMIPv6	
6		Long-Term Evolution (LTE) of 3GPP	7
	6.1	Long-Term Evolution (LTE) of 3GPP : LTE System Overview, Evolution from UMTS to LTE	
	6.2	LTE/SAE Requirements, SAE Architecture	
	6.3	EPS: Evolved Packet System, E-UTRAN, Voice over LTE (VoLTE), Introduction to LTE-Advanced	
	6.4	Self Organizing Network (SON-LTE), SON for Heterogeneous Networks (HetNet), Comparison between Different Generations (2G, 3G, 4G and 5G), Introduction to 5G	

Textbooks:

1	Jochen Schiller, “ Mobile Communication ”, Addison Wesley, Pearson Education
2	William Stallings “ Wireless Communications & Networks ”, Second Edition, Pearson Education
3	Christopher Cox, “ An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications ”, Wiley publications
4	Raj Kamal, “ Mobile Computing ”, 2/e, Oxford University Press-New

References:

1	Seppo Hamalainen, Henning Sanneck, Cinzia Sartori, “ LTE Self-Organizing Networks (SON): Network Management Automation for Operational Efficiency ”, Wiley publications
2	Ashutosh Dutta, Henning Schulzrinne “ Mobility Protocols and Handover Optimization: Design, Evaluation and Application ”, IEEE Press, Wiley Publication
3	Michael Gregg, “ Build your own security lab ”, Wiley India edition
4	Dipankar Raychaudhuri, Mario Gerla, “ Emerging Wireless Technologies and the Future Mobile Internet ”, Cambridge
5	Andreas F. Molisch, “ Wireless Communications ”, Second Edition, Wiley Publication

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://www.coursera.org/learn/smart-device-mobile-emerging-technologies
2	https://nptel.ac.in/courses/106/106/106106167/

Course Code:	Course Title	Credit
CSC604	Artificial Intelligence	3

Prerequisite: Discrete Mathematics, Data Structures	
Course Objectives:	
1	To conceptualize the basic ideas and techniques underlying the design of intelligent systems.
2	To make students understand and Explore the mechanism of mind that enables intelligent thought and action.
3	To make students understand advanced representation formalism and search techniques.
4	To make students understand how to deal with uncertain and incomplete information.
Course Outcomes: At the end of the course, the students will be able to	
1	Ability to develop a basic understanding of AI building blocks presented in intelligent agents.
2	Ability to choose an appropriate problem solving method and knowledge representation technique.
3	Ability to analyze the strength and weaknesses of AI approaches to knowledge– intensive problem solving.
4	Ability to design models for reasoning with uncertainty as well as the use of unreliable information.
5	Ability to design and develop AI applications in real world scenarios.

Module		Content	Hrs
1		Introduction to Artificial Intelligence	4
	1.1	Introduction, History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Applications of AI, Current trends in AI.	
2		Intelligent Agents	4
	2.1	Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Agent.	
	2.2	Solving problem by Searching: Problem Solving Agent, Formulating Problems, Example Problems.	
3		Problem solving	10
	3.1	Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Methods: Greedy best first Search, A* Search, Memory bounded heuristic Search.	
	3.2	Local Search Algorithms and Optimization Problems: Hill climbing search Simulated annealing, Genetic algorithms.	
	3.3	Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning	
4		Knowledge and Reasoning	12
	4.1	Knowledge based Agents, Brief Overview of propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining.	
	4.2	Knowledge Engineering in First-Order Logic, Unification, Resolution	

	4.3	Uncertain Knowledge and Reasoning: Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Simple Inference in belief network	
5		Planning and Learning	5
	5.1	The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning.	
	5.2	Learning: Forms of Learning, Theory of Learning, PAC learning. Introduction to statistical learning (Introduction only) Introduction to reinforcement learning: Learning from Rewards, Passive Reinforcement Learning, Active reinforcement Learning	
6		AI Applications	4
		A. Introduction to NLP- Language models, Grammars, Parsing B. Robotics - Robots, Robot hardware, Problems Robotics can solve C. AI applications in Healthcare, Retail, Banking	

Textbooks:

1	Stuart J. Russell and Peter Norvig, " Artificial Intelligence: A Modern Approach ", Fourth Edition" Pearson Education, 2020.
2	Saroj Kaushik, " Artificial Intelligence ", Cengage Learning, First edition, 2011
3	George F Luger, " Artificial Intelligence " Low Price Edition, Fourth edition, Pearson Education.,2005

References:

1	Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.
2	Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
3	Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.
4	Elaine Rich and Kevin Knight, " Artificial Intelligence ", Third Edition, McGraw Hill Education,2017.

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1	Question paper will comprise a total of six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four questions need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Useful Links

1	https://nptel.ac.in/courses/106/105/106105078/
2	https://thestempedia.com/blog/simple-ai-and-machine-learning-projects-for-students-and-beginners/
3	https://nptel.ac.in/courses/106/105/106105079/

Course Code:	Course Title	Credit
CSDLO6011	Internet of Things	3

Prerequisite: C Programming, Digital Logic and Computer Architecture, Microprocessor, Computer Networks.

Course Objectives:

1	To equip students with the fundamental knowledge and basic technical competence in the field of Internet of Things (IoT).
2	To emphasize on core IoT functional Stack to build assembly language programs. To learn the Core IoT Functional Stack.
3	To understand the different common application protocols for IoT and apply IoT knowledge to key industries that IoT is revolutionizing.
4	To examines various IoT hardware items and software platforms used in projects for each platform that can be undertaken by a beginner, hobbyist, student, academician, or researcher to develop useful projects or products.

Course Outcomes: On the completion of the course, learners will be able to:

1	Understand the concepts of IoT and the Things in IoT.
2	Emphasize core IoT functional Stack and understand application protocols for IoT.
3	Apply IoT knowledge to key industries that IoT is revolutionizing.
4	Examines various IoT hardware items and software platforms used in projects.

Module		Content	Hrs
1		Introduction to Internet of Things (IoT)	7
	1.1	What is IoT? - IoT and Digitization	
	1.2	IoT Impact – Connected Roadways, Connected Factory, Smart Connected Buildings, Smart Creatures	
	1.3	Convergence of IT and OT, IoT Challenges	
	1.4	The oneM2M IoT Standardized Architecture	
	1.5	The IoT World Forum (IoTWF) Standardized Architecture	
	1.6	IoT Data Management and Compute Stack – Design considerations and Data related problems, Fog Computing, Edge Computing, The Hierarchy of Edge, Fog and Cloud	
2		Things in IoT	7
	2.1	Sensors/Transducers – Definition, Principles, Classifications, Types, Characteristics and Specifications	
	2.2	Actuators – Definition, Principles, Classifications, Types, Characteristics and Specifications	
	2.3	Smart Object – Definition, Characteristics and Trends	
	2.4	Sensor Networks – Architecture of Wireless Sensor Network, Network Topologies	
	2.5	Enabling IoT Technologies - Radio Frequency Identification Technology, Micro-Electro-Mechanical Systems (MEMS), NFC (Near Field Communication), Bluetooth Low Energy (BLE), LTE-A (LTE Advanced), IEEE 802.15.4–Standardization and Alliances, ZigBee.	
3		The Core IoT Functional Stack	6
	3.1	Layer 1 – Things: Sensors and Actuators Layer	

	3.2	Layer 2 – Communications Network Layer, Access Network Sublayer, Gateways and Backhaul Sublayer, Network Transport Sublayer, IoT Network Management Sublayer	
	3.3	Layer 3 – Applications and Analytics Layer, Analytics Vs. Control Applications, Data Vs. Network Analytics, Data Analytics Vs. Business Benefits, Smart Services	
4		Application Protocols for IoT	7
	4.1	The Transport Layer	
	4.2	IoT Application Transport Methods	
	4.3	Application Layer Protocol Not Present	
	4.4	SCADA - Background on SCADA, Adapting SCADA for IP, Tunneling Legacy SCADA over IP Networks, SCADA Protocol Translation, SCADA Transport over LLNs with MAP-T,	
	4.5	Generic Web-Based Protocols	
	4.6	IoT Application Layer Protocols – CoAP and MQTT	
5		Domain Specific IoTs	6
	5.1	Home Automation – Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors	
	5.2	Cities – Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance	
	5.3	Environment – Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection	
	5.4	Energy – Smart Grids, Renewable Energy Systems, Prognostics	
	5.5	Retail – Inventory Management, Smart Payments, Smart Vending Machines	
	5.6	Logistics – Route Generation & Scheduling, Fleet Tracking, Shipment Monitoring	
	5.7	Agriculture – Smart Irrigation, Green House Control	
	5.8	Industry – Machine Diagnostics & Prognosis, Indoor Air Quality Monitoring	
	5.9	Health & Lifestyle – Health & Fitness Monitoring, Wearable Electronics	
6		Create your own IoT	6
	6.1	IoT Hardware - Arduino, Raspberry Pi, ESP32, Cloudbit/Littlebits, Particle Photon, Beaglebone Black.	
	6.2	IoT Software - languages for programming IoT hardware, for middleware applications and API development, for making front ends, REST and JSON-LD	
	6.3	A comparison of IoT boards and platforms in terms of computing	
	6.4	A comparison of IoT boards and platforms in terms of development environments and communication standards	
	6.5	A comparison of boards and platforms in terms of connectivity	
	6.6	A comparison of IoT software platforms	

Textbooks:

1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, <i>“IoT Fundamentals – Networking Technologies, Protocols, and Use Cases for the Internet of Things”</i> , 1 st Edition, Published by Pearson Education, Inc, publishing as Cisco Press, 2017.

2	Hakima Chaouchi, <i>“The Internet of Things - Connecting Objects to the Web”</i> , 1 st Edition, Wiley, 2010.
3	Perry Lea, <i>“Internet of things For Architects”</i> , 1 st Edition, Packt Publication, 2018
4	Arshdeep Bahga, Vijay Madisetti, <i>“Internet of Things – Hands-On Approach”</i> , 2 nd Edition, Universities Press, 2016.
References:	
1	Adrian McEwen & Hakim Cassimally, <i>“Designing the Internet of Things”</i> , 1 st Edition, Wiley, 2014.
2	Donald Norris, <i>“Raspberry Pi – Projects for the Evil Genius”</i> , 2 nd Edition, McGraw Hill, 2014.
3	Anand Tamboli, <i>“Build Your Own IoT Platform”</i> , 1 st Edition, Apress, 2019.

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105166/
2	https://nptel.ac.in/courses/108/108/108108098/
3	https://nptel.ac.in/courses/106/105/106105195/
4	https://www.coursera.org/specializations/IoT

Course Code:	Course Title	Credit
CSDLO6012	Digital Signal & Image Processing	3

Prerequisite: Applied Engineering Mathematics	
Course Objectives:	
1	To understand the fundamental concepts of digital signal processing and Image processing
2	To explore DFT for 1-D and 2-D signal and FFT for 1-D signal
3	To apply processing techniques on 1-D and Image signals
4	To apply digital image processing techniques for edge detection
Course Outcomes: On successful completion of course, learners will be able to:	
1	Understand the concept of DT Signal and DT Systems
2	Classify and analyze discrete time signals and systems
3	Implement Digital Signal Transform techniques DFT and FFT
4	Use the enhancement techniques for digital Image Processing
5	Apply image segmentation techniques

Module No.	Unit No.	Topic details	Hrs.
1.0		Discrete-Time Signal and Discrete-Time System	10
	1.1	Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations (shifting, reversal, scaling, addition, multiplication).	
	1.2	Classification of Discrete-Time Signals, Classification of Discrete-Systems	
	1.3	Linear Convolution formulation for 1-D signal (without mathematical proof), Circular Convolution (without mathematical proof), Linear convolution using Circular Convolution. Auto and Cross Correlation formula evaluation, Concept of LTI system, Output of DT system using Time Domain Linear Convolution.	
2.0		Discrete Fourier Transform	05
	2.1	Introduction to DTFT, DFT, Relation between DFT and DTFT, IDFT	
	2.2	Properties of DFT without mathematical proof (Scaling and Linearity, Periodicity, Time Shift and Frequency Shift, Time Reversal, Convolution Property and Parseval's Energy Theorem). DFT computation using DFT properties.	
	2.3	Convolution of long sequences, Introduction to 2-D DFT	
3.0		Fast Fourier Transform	04
	3.1	Need of FFT, Radix-2 DIT-FFT algorithm,	
	3.2	DIT-FFT Flow graph for N=4 and 8, Inverse FFT algorithm.	
	3.3	Spectral Analysis using FFT	
4.0		Digital Image Fundamentals	05
	4.1	Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization	
	4.2	Representation of Digital Image, Connectivity	
	4.3	Image File Formats: BMP, TIFF and JPEG.	
5.0		Image Enhancement in Spatial domain	09
	5.1	Gray Level Transformations, Zero Memory Point Operations,	
	5.2	Histogram Processing, Histogram equalization.	

	5.3	Neighborhood processing, Image averaging, Image Subtraction, Smoothing Filters - Low pass averaging, Sharpening Filters-High Pass Filter, High Boost Filter, Median Filter for reduction of noise	
6.0		Image Segmentation	06
	6.1	Fundamentals. Segmentation based on Discontinuities and Similarities	
	6.2	Point, line and Edge Detection. Image edge detection using Robert, Prewitt and Sobel masks, Image edge Detection using Laplacian mask	
	6.3	Region based segmentation: Region Growing, Region Splitting and Merging	
		Total	39

Textbooks:	
1	John G. Proakis, Dimitris and G .Manolakis, “ Digital Signal Processing: Principles, Algorithms, and Applications ”, 4th Edition, Pearson Education, 2007
2	A. Anand Kumar, “ Digital Signal Processing ”, 2nd Edition, PHI Learning Pvt. Ltd. 2014.
3	Rafel C. Gonzalez and Richard E. Woods, “ Digital Image Processing ”, Pearson Education Asia, 4th Edition, 2018.
4	S. Sridhar, “ Digital Image Processing ”, 2nd Edition, Oxford University Press, 2012.
References:	
1	Sanjit Mitra, “ Digital Signal Processing: A Computer Based Approach ”, 4th Edition, Tata McGraw Hill, 2013
2	S. Salivahanan, A. Vallavaraj, and C. Gnanapriya, “ Digital Signal Processing ”, 2nd Edition, Tata McGraw Hill Publication, 2011.
3	S. Jayaraman, E. Esakkirajan and T. Veerkumar, “ Digital Image Processing ”, 3 rd Edition, Tata McGraw Hill Education Private Ltd, 2009.
4	Anil K. Jain, “ Fundamentals of Digital Image Processing ”, 4th Edition, Prentice Hall of India Private Ltd,.1989
Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 50% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Useful Links	
1	https://nptel.ac.in/courses/
2	https://swayam.gov.in

Course Code:	Course Title	Credit
CSDLO6013	Quantitative Analysis	3

Prerequisite: Applied Mathematics

Course Objectives:

- 1 Introduction to the basic concepts in Statistics
- 2 Understand concept of data collection & sampling methods.
- 3 Introduction to Regression, Multiple Linear Regression
- 4 Draw inference using Statistical inference methods
- 5 Tests of hypotheses

Course Outcomes:

- 1 Recognize the need of Statistics and Quantitative Analysis
- 2 Apply the data collection and the sampling methods.
- 3 Analyze using concepts of Regression, Multiple Linear Regression
- 4 Formulate Statistical inference drawing methods.
- 5 Apply Testing of hypotheses

Module	Content	Hrs
1	Introduction to Statistics	6
	Functions – Importance – Uses and Limitations of Statistics. Statistical data– Classification, Tabulation, Diagrammatic & Graphic representation of data	
2	Data Collection & Sampling Methods	6
	Primary & Secondary data, Sources of data, Methods of collecting data. Sampling – Census & Sample methods –Methods of sampling, Probability Sampling and Non-Probability Sampling.	
3	Introduction to Regression	8
	Mathematical and Statistical Equation – Meaning of Intercept and Slope – Error term – Measure for Model Fit –R ² – MAE – MAPE.	
4	Introduction to Multiple Linear Regression	8
	Multiple Linear Regression Model, Partial Regression Coefficients, Testing Significance overall significance of Overall fit of the model, Testing for Individual Regression Coefficients	
5	Statistical inference	6
	Random sample -Parametric point estimation unbiasedness and consistence - method of moments and method of maximum likelihood.	
6	Tests of hypotheses	5
	Null and Alternative hypotheses. Types of errors. Neyman-Pearson lemma- MP and UMP tests.	

Textbooks:

- 1 Agarwal, B.L. (2006):-Basic Statistics. Wiley Eastern Ltd., New Delhi
- 2 Gupta, S. P. (2011):-Statistical Methods. Sultanchand&Sons, New Delhi
- 3 Sivathanupillai, M &Rajagopal, K. R. (1979):-Statistics for Economics Students.
- 4 Hogg ,R.V. and Craig, A.T.(2006), An introduction to mathematical statistics, Amerind publications.

References:

1	Arora, P.N., Sumeet Arora, S. Arora (2007):- Comprehensive Statistical Methods. Sultan Chand, New Delhi
2	Montgomery, D.C., Peck E.A, & Vining G.G.(2003). Introduction to Linear Regression Analysis. John Wiley and Sons, Inc. NY
3	Mood AM, Graybill FA, and Boes, D.C.(1985), Introduction to the theory of statistics, McGrawhill Book Company, New Delhi.
4	Kapur, J.N. and Saxena, H.C.(1970), Mathematical statistics, Sultan Chand & company, New Delhi..

Assessment:	
Internal Assessment:	
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.	
End Semester Theory Examination:	
1	Question paper will comprise of total six questions.
2	All question carries equal marks
3	Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4	Only Four question need to be solved.
5	In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

Lab Code	Lab Name	Credit
CSL601	System Programming and Compiler Construction Lab	1
Prerequisite: Theoretical computer science, Operating system. Computer Organization and Architecture		
Lab Outcomes: At the end of the course, the students will be able to		
1	Generate machine code by implementing two pass assemblers.	
2	Implement Two pass macro processor.	
3	Parse the given input string by constructing Top down/Bottom-up parser.	
4	Identify and Validate tokens for given high level language and Implement synthesis phase of compiler.	
5	Explore LEX & YACC tools.	

Suggested List of Experiments	
Sr. No.	Title of Experiment
1	Implementations of two pass Assembler.
2	Implementation of Two pass Macro Processor.
3	Implementation of Lexical Analyzer.
4	Implementation of Parser (Any one).
5	Implementation of Intermediate code generation phase of compiler.
6	Implementation of code generation phase of compiler.
7	Study and implement experiments on LEX, YACC.

Reference Books:	
1	Andrew W. Appel Princeton University. Jens Palsberg <i>Modern Compiler. Implementation in Java</i> , Second Edition. Purdue University. CAMBRIDGE University press @2002.
2	Charles N. Fischer, Richard J. LeBlanc <i>Crafting a compiler with C</i> , pearson Education 2007

Term Work:	
1	Term work should consist of experiments based on suggested experiment list.
2	Journal must include at least 2 assignments on content of theory and practical of “System Programming and Compiler Construction”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	The distribution of marks for term work shall be as follows: Laboratory work (experiments/case studies):(15) Marks. Assignment: (05) Marks. Attendance (05) Marks TOTAL: (25) Marks.
Oral & Practical exam will be based on the above and CSC601 syllabus.	

Lab Code	Lab Name	Credit
CSL602	Cryptography & System Security Lab	1

Prerequisite: Computer Network	
Lab Objectives:	
1	To apply various encryption techniques
2	To study and implement various security mechanism
3	To explore the network security concept and tools
Lab Outcomes: At the end of the course, the students will be able to	
1	apply the knowledge of symmetric and asymmetric cryptography to implement simple ciphers.
2	explore the different network reconnaissance tools to gather information about networks.
3	explore and use tools like sniffers, port scanners and other related tools for analysing packets in a Network.
4	set up firewalls and intrusion detection systems using open-source technologies and to explore email security.
5	explore various attacks like buffer-overflow and web application attack.

Suggested List of Experiments	
Sr. No	Title of Experiment
1	Design and Implementation of a product cipher using Substitution and Transposition ciphers.
2	Implementation and analysis of RSA crypto system.
3	Implementation of Diffie Hellman Key exchange algorithm
4	For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs.
5	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, ns lookup to gather information about networks and domain registrars.
6	Study of packet sniffer tools: wireshark,: 1. Download and install wireshark and capture icmp, tcp, and http packets in promiscuous mode. 2. Explore how the packets can be traced based on different filters.
7	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, xmas scan etc.
8	Detect ARP spoofing using nmap and/or open-source tool ARPWATCH and wireshark. Use arping tool to generate gratuitous arps and monitor using wireshark
9	Simulate DOS attack using Hping, hping3 and other tools
10	Simulate buffer overflow attack using Ollydbg, Splint, Cpp check etc
11	a. Set up IPSEC under LINUX. b. Set up Snort and study the logs.
12	Setting up personal Firewall using iptables
13	Explore the GPG tool of linux to implement email security
14	SQL injection attack, Cross-Cite Scripting attack simulation
15	Case Study /Seminar: Topic beyond syllabus related to topics covered.

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of

	“Cryptography and System Security “
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	The distribution of marks for term work shall be as follows: Lab Performance 15 Marks Assignments 05 Marks Attendance (Theory & practical) 05 Marks

Lab Code	Lab Name	Credit
CSL603	Mobile Computing Lab	1

Prerequisite: Computer Networks

Lab Objectives:

- 1 To learn the mobile computing tools and software for implementation.
- 2 To understand the security algorithms in mobile networks
- 3 To learn security concepts

Lab Outcomes: At the end of the course, the students will be able to

- 1 develop and demonstrate mobile applications using various tools
- 2 articulate the knowledge of GSM, CDMA & Bluetooth technologies and demonstrate it.
- 3 Students will be able to carry out simulation of frequency reuse, hidden/exposed terminal problem
- 4 implement security algorithms for mobile communication network
- 5 demonstrate simulation and compare the performance of Wireless LAN

Suggested List of Experiments

The softwares like Android Studio, J2ME, NS2, NS3 and any other software which is suitable are recommended for performing the practical.

Sr. No.	Title of Experiment
1	Implementation a Bluetooth network with application as transfer of a file from one device to another.
2	To implement a basic function of Code Division Multiple Access (CDMA).
3	Implementation of GSM security algorithms (A3/A5/A8)
4	Illustration of Hidden Terminal/Exposed terminal Problem. Consider two Wi-fi base stations (STA) and an access point (AP) located along the x-axis. All the nodes are fixed. The AP is situated at the middle of the two STA, the distance of separation being 150 m. [variable]. Node #0 and node #1 are the hidden terminals. Both are transmitting some data to the AP (almost at same rate) at the same time. The loss across the wireless link between each STA and the AP is fixed at 50 dB irrespective of the distance of separation. To study how RTS/CTS helps in wireless networks, 1. No RTS/CTS is being sent. 2. Nodes do exchange RTS/CTS packets. Compare the no. of packet retransmissions required in both the cases (as obtained in the output) and compare the results.
5	To setup & configuration of Wireless Access Point (AP). Analyze the Wi-Fi communication range in the presence of the access point (AP) and the base station (BS). Consider BS and AP are static. Find out the maximum distance to which two way communications is possible. Try multiple iterations by adjusting its distance in the code and test it.
6	Study of security tools (like Kismet, Netstumbler)
7	Develop an application that uses GUI components.
8	Write an application that draws basic graphical primitives on the screen.
9	Develop an application that makes use of database.
10	Develop a native application that uses GPS location information.
11	Implement an application that creates an alert upon receiving a message.

12	Implementation of income tax/loan EMI calculator and deploy the same on real devices (Implementation of any real time application)

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “ Mobile Computing”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory& Practical: 05-marks, Assignments: 05-marks)

Useful Links	
1	https://nptel.ac.in/courses/106/106/106106147/
2	https://www.coursera.org/learn/smart-device-mobile-emerging-technologies

Lab Code	Lab Name	Credit
CSL604	Artificial Intelligence Lab	1

Prerequisite: Discrete Mathematics, Data Structure	
Lab Objectives:	
1	To realize the basic techniques to build intelligent systems
2	To apply appropriate search techniques used in problem solving
3	To create knowledge base for uncertain data
Lab Outcomes: At the end of the course, the students will be able to	
1	Identify languages and technologies for Artificial Intelligence
2	Understand and implement uninformed and informed searching techniques for real world problems.
3	Create a knowledge base using any AI language.
4	Design and implement expert systems for real world problems.

Suggested List of Experiments (programming in python)	
Sr. No.	Title of Experiment
1	One case study on AI applications published in IEEE/ACM/Springer or any prominent journal.
2	Assignments on State space formulation and PEAS representation for various AI applications
3	Program on uninformed search methods.
4	Program on informed search methods.
5	Program on Game playing algorithms.
6	Program for first order Logic
7	Planning Programming
8	Implementation for Bayes Belief Network
Note: Any other practical covering the syllabus topics and subtopics can be conducted. The programming assignment for First order logics could be in the form of a mini project	

Term Work:	
1	Term work should consist of a minimum of 8 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of “Artificial Intelligence”
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)
Oral & Practical exam: Based on the entire syllabus of CSC604: Artificial Intelligence	

Lab Code	Lab Name	Credit	
CSL605	Cloud Computing	2	
Prerequisite: Computer Networks			
Lab Objectives: The course has following objectives			
1	To make students familiar with key concepts of virtualization.		
2	To make students familiar with various deployment models of cloud such as private, public, hybrid and community so that they star using and adopting appropriate type of cloud for their application.		
3	To make students familiar with various service models such as IaaS, SaaS, PaaS, Security as a Service (SECaaS) and Database as a Service.		
4	To make students familiar with security and privacy issues in cloud computing and how to address them.		
Lab Outcomes: At the end of the course, the students will be able to			
1	Implement different types of virtualization techniques.		
2	Analyze various cloud computing service models and implement them to solve the given problems.		
3	Design and develop real world web applications and deploy them on commercial cloud(s).		
4	Explain major security issues in the cloud and mechanisms to address them.		
5	Explore various commercially available cloud services and recommend the appropriate one for the given application.		
6	Implement the concept of containerization		
Module	Detailed Contents	Hours	LO
01	Title: Introduction and overview of cloud computing. Objective: To understand the origin of cloud computing, cloud cube model, NIST model, characteristics of cloud, different deployment models, service models, advantages and disadvantages.	2	2
02	Title: To study and implement Hosted Virtualization using VirtualBox& KVM. Objective: To know the concept of Virtualization along with their types, structures and mechanisms. This experiment should have demonstration of creating and running Virtual machines inside hosted hypervisors like VirtualBox and KVM with their comparison based on various virtualization parameters.	2	1
03	Title: To study andImplement Bare-metal Virtualization using Xen, HyperV or VMware Esxi. Objective: To understand the functionality of Bare-metal hypervisors and their relevance in cloud computing platforms. This experiment should have demonstration of install, configure and manage Bare Metal hypervisor along with instructions to create and run virtual machines inside it. It should also emphasize on accessing VMs in different environments along with additional services provided by them like Load balancing, Auto-Scaling, Security etc.	4	1

04	Title: To study and Implement Infrastructure as a Service using AWS/Microsoft Azure. Objective: To demonstrate the steps to create and run virtual machines inside Public cloud platform. This experiment should emphasize on creating and running Linux/Windows Virtual machine inside Amazon EC2 or Microsoft Azure Compute and accessing them using RDP or VNC tools.	4	2
05	Title: To study and Implement Platform as a Service using AWS Elastic Beanstalk/ Microsoft Azure App Service. Objective: To demonstrate the steps to deploy Web applications or Web services written in different languages on AWS Elastic Beanstalk/ Microsoft Azure App Service.	4	2
06	Title: To study and Implement Storage as a Service using Own Cloud/ AWS S3, Glaciers/ Azure Storage. Objective: To understand the concept of Cloud storage and to demonstrate the different types of storages like object storage, block level storages etc. supported by Cloud Platforms like Own Cloud/ AWS S3, Glaciers/ Azure Storage.	4	2
07	Title: To study and Implement Database as a Service on SQL/NOSQL databases like AWS RDS, AZURE SQL/ MongoDB Lab/ Firebase. Objective: To know the concept of Database as a Service running on cloud and to demonstrate the CRUD operations on different SQL and NOSQL databases running on cloud like AWS RDS, AZURE SQL/ Mongo Lab/ Firebase.	2	2
08	Title: To study and Implement Security as a Service on AWS/Azure Objective: To understand the Security practices available in public cloud platforms and to demonstrate various Threat detection, Data protection and Infrastructure protection services in AWS and Azure.	3	4
09	Title: To study and implement Identity and Access Management (IAM) practices on AWS/Azure cloud. Objective: To understand the working of Identity and Access Management IAM in cloud computing and to demonstrate the case study based on Identity and Access Management (IAM) on AWS/Azure cloud platform.	2	2
10	Title: To study and Implement Containerization using Docker Objective: To know the basic differences between Virtual machine and Container. It involves demonstration of creating, finding, building, installing, and running Linux/Windows application containers inside local machine or cloud platform.	4	6

11	Title: To study and implement container orchestration using Kubernetes Objective: To understand the steps to deploy Kubernetes Cluster on local systems, deploy applications on Kubernetes, creating a Service in Kubernetes, develop Kubernetes configuration files in YAML and creating a deployment in Kubernetes using YAML,	4	6
12	Mini-project: Design a Web Application hosted on public cloud platform [It should cover the concept of IaaS, PaaS, DBaaS, Storage as a Service, Security as a Service etc.]	4	3, 5

Sr. No.	Suggested Assignment List (Any two)	LO
1	Assignment based on selection of suitable cloud platform solution based on requirement analysis considering given problem statement	5
2	Assignment on recent trends in cloud computing and related technologies	5
3	Assignment on comparative study of different computing technologies [Parallel, Distributed, Cluster, Grid, Quantum]	5
4	Comparative study of different hosted and bare metal Hypervisors with suitable parameters along with their use in public/private cloud platform	1
5	Assignment on explore and compare the similar type of services provided by AWS and Azure [Any ten services]	5

Digital Material:		
Sr. No.	Topic	Link
1	Introduction and overview of cloud computing	https://www.nist.gov/system/files/documents/itl/cloud/NIST_SP-500-291_Version-2_2013_June18_FINAL.pdf
2	Hosted Virtualization using KVM	https://phoenixnap.com/kb/ubuntu-install-kvm/
3	Baremetal Virtualization using Xen	https://docs.citrix.com/en-us/xenserver/7-1/install.html
4	IaaS, PaaS, STaaS, DbaaS, IAM and Security as a Service on AWS and Azure	1) AWS https://docs.aws.amazon.com/ 2) MS Azure https://docs.microsoft.com/en-us/azure
5	Docker	https://docs.docker.com/get-started/

6	Kubernetes	https://kubernetes.io/docs/home/

Textbooks:

1	Bernard Golden, “Amazon Web Services for Dummies”, John Wiley & Sons, Inc.
2	Michael Collier, Robin Shahan, “Fundamentals of Azure, Microsoft Azure Essentials”, Microsoft Press.
3	RajkumarBuyya, Christian Vecchiola, S ThamaraiSelvi, “Mastering Cloud Computing”, Tata McGraw-Hill Education.
4	Barrie Sosinsky, “Cloud Computing Bible”, Wiley publishing.
5	John Paul Mueller, “AWS for Admins for Developers”, John Wiley & Sons, Inc.
6	Ken Cochrane, Jeeva S. Chelladhurai, NeependraKhare , “Docker Cookbook - Second Edition”, Packt publication
7	Jonathan Baier, “Getting Started with Kubernetes-Second Edition”, Packt Publication.

Term Work:

1	Term work should consist of 10 experiments and a mini project.
2	Journal must include at least 2 assignments.
3	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 50 Marks (Experiments: 15-marks, Mini project (Implementation) 15 marks, Mini Project Presentation & Report [for deployment, utilization, monitoring and billing] 10 Marks, Attendance 05-marks, Assignments: 05-marks)
Oral examination will be based on Laboratory work, mini project and above syllabus.	

Course code	Course Name	Credits
CSM601	Mini Project 2B	02

Objectives	
1	To understand and identify the problem
2	To apply basic engineering fundamentals and attempt to find solutions to the problems.
3	Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
4	To develop communication skills and improve teamwork amongst group members and inculcate the process of self-learning and research.
Outcome: Learner will be able to...	
1	Identify societal/research/innovation/entrepreneurship problems through appropriate literature surveys
2	Identify Methodology for solving above problem and apply engineering knowledge and skills to solve it
3	Validate, Verify the results using test cases/benchmark data/theoretical/inferences/experiments/simulations
4	Analyze and evaluate the impact of solution/product/research/innovation /entrepreneurship towards societal/environmental/sustainable development
5	Use standard norms of engineering practices and project management principles during project work
6	Communicate through technical report writing and oral presentation. • The work may result in research/white paper/ article/blog writing and publication • The work may result in business plan for entrepreneurship product created • The work may result in patent filing.
7	Gain technical competency towards participation in Competitions, Hackathons, etc.
8	Demonstrate capabilities of self-learning, leading to lifelong learning.
9	Develop interpersonal skills to work as a member of a group or as leader
Guidelines for Mini Project	
1	Mini project may be carried out in one or more form of following: Product preparations, prototype development model, fabrication of set-ups, laboratory experiment development, process modification/development, simulation, software development, integration of software (frontend-backend) and hardware, statistical data analysis, creating awareness in society/environment etc.
2	Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
3	Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
4	Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
5	A logbook may be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
6	Faculty supervisors may give inputs to students during mini project activity; however, focus shall be on self-learning.
7	Students under the guidance of faculty supervisor shall convert the best solution into a working model using various components of their domain areas and demonstrate.
8	The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai. Software requirement specification (SRS) documents, research papers, competition certificates may be submitted as part of annexure to the report.

9	With the focus on self-learning, innovation, addressing societal/research/innovation problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 2 in semesters V and VI.
10	However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above, gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

Term Work

The review/ progress monitoring committee shall be constituted by the heads of departments of each institute. The progress of the mini project to be evaluated on a continuous basis, based on the SRS document submitted. minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below:		Marks 25
1	Marks awarded by guide/supervisor based on logbook	10
2	Marks awarded by review committee	10
3	Quality of Project report	05

Review / progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines

One-year project:

1	In the first semester the entire theoretical solution shall be made ready, including components/system selection and cost analysis. Two reviews will be conducted based on a presentation given by a student group. ☐ First shall be for finalization of problem ☐ Second shall be on finalization of proposed solution of problem.
2	In the second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. ☐ First review is based on readiness of building working prototype to be conducted. ☐ Second review shall be based on poster presentation cum demonstration of working model in the last month of the said semester.

Half-year project:

1	In this case in one semester students' group shall complete project in all aspects including, ☐ Identification of need/problem ☐ Proposed final solution ☐ Procurement of components/systems ☐ Building prototype and testing
2	Two reviews will be conducted for continuous assessment, ☐ First shall be for finalization of problem and proposed solution ☐ Second shall be for implementation and testing of solution.

Mini Project shall be assessed based on following points

1	Clarity of problem and quality of literature Survey for problem identification
2	Requirement gathering via SRS/ Feasibility Study
3	Completeness of methodology implemented

4	Design, Analysis and Further Plan
5	Novelty, Originality or Innovativeness of project
6	Societal / Research impact
7	Effective use of skill set : Standard engineering practices and Project management standard
8	Contribution of an individual's as member or leader
9	Clarity in written and oral communication
10	Verification and validation of the solution/ Test Cases
11	Full functioning of working model as per stated requirements
12	Technical writing /competition/hackathon outcome being met

In one year project (sem V and VI), first semester evaluation may be based on first 10 criteria and remaining may be used for second semester evaluation of performance of students in mini projects.

In case of half year projects (completing in VI sem) all criteria's in generic may be considered for evaluation of performance of students in mini projects.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

1	Report should be prepared as per the guidelines issued by the University of Mumbai.
2	Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by the head of Institution.
3	Students shall be motivated to publish a paper/participate in competition based on the work in Conferences/students competitions.

UNIVERSITY OF MUMBAI



Bachelor of Engineering **in** **Electronics and Telecommunication** **Engineering**

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year
2019–2020)

UNIVERSITY OF MUMBAI**Syllabus for Approval**

Sr. No.	Heading	Particulars
1	Title of the Course	Third Year in Bachelor of Electronics and Telecommunication Engineering
2	Eligibility for Admission	After Passing Second Year Engineering as per the Ordinance 0.6243
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	Ordinance 0.6243
5	No. of Years / Semesters	8 semesters
6	Level	P.G. / U.G./Diploma / Certificate (Strike out which is not applicable)
7	Pattern	Yearly / Semester (Strike out which is not applicable)
8	Status	New / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	With effect from Academic Year: 2021-2022

Date **29-06-2021**

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents **from NPTEL/ Swayam Platform**

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By BoS

Technological developments in the field of electronics and telecommunication engineering have revolutionized the way people see the world today. Hence, there is a need for continuously enriching the quality of education by a regular revision in the curriculum, which will help our students achieve better employability, start-ups, and other avenues of higher studies. The current revision in the Bachelor of Engineering program (REV- 2019 ‘C’ Scheme) aims at providing a strong foundation with required analytical concepts in the field of electronics and telecommunication engineering.

Some of the salient features of this revised curriculum are as below and they fall in line with the features in AICTE Model Curriculum.

1. The curriculum is designed in such a way that it encourages innovation and research as the total number of credits has been reduced from around 200 credits in an earlier curriculum to 171 credits in the current revision.
2. In the second and third-year curriculum, skill-based laboratories and mini-projects are introduced.
3. It will result in the students developing a problem-solving approach and will be able to meet the challenges of the future.
4. The University of Mumbai and BoS – Electronics and Telecommunication Engineering will ensure the revision of the curriculum on regular basis in the future as well and this update will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

The BoS would like to thank all the subject experts, industry representatives, alumni, and various other stakeholders for their sincere efforts and valuable time in the preparation of course contents, reviewing the contents, giving valuable suggestions, and critically analyzing the contents.

Board of Studies in Electronics and Telecommunication Engineering

Dr. Faruk Kazi: Chairman

Dr. V. N. Pawar: Member

Dr. Ravindra Duche: Member

Dr. Milind Shah: Member

Dr. R. K. Kulkarni: Member

Dr. Baban U. Rindhe: Member

Dr. Mrs. Nair: Member

Dr. Nalbarwar: Member

Dr. Sudhakar Mande: Member

Dr. S. D. Deshmukh: Member

Program Structure for Third Year Engineering
Semester V & VI
UNIVERSITY OF MUMBAI
(With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC501	Digital Communication	3	--	--	3	--	--	3
ECC502	Discrete Time Signal Processing	3	--	--	3	--	--	3
ECC503	Digital VLSI	3	--	--	3	--	--	3
ECC504	Random Signal Analysis	3	--	1	3	--	1	4
ECCDLO 501X	Department Optional Course-1	3	--	--	3	--	--	3
ECL501	Digital Communication Lab	--	2	--	--	1	--	1
ECL502	Discrete Time Signal Processing Lab	--	2	--	--	1	--	1
ECL503	Digital VLSI Lab	--	2	--	--	1	--	1
ECL504	Professional Communication & Ethics - II	--	2*+2~	--	--	2	--	2
ECM501	Mini Project 2A- Embedded System Project	--	4\$	--	--	2	--	2
Total		15	14	1	15	07	1	23

* Theory should be conducted for the full class.

~ Batch-wise practical's to be conducted

\$ Indicates work load of a learner (Not Faculty) for Mini Project 2A. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC501	Digital Communication	20	20	20	80	3	--	--	100
ECC502	Discrete Time Signal Processing	20	20	20	80	3	--	--	100
ECC503	Digital VLSI	20	20	20	80	3	--	--	100
ECC504	Random Signal Analysis	20	20	20	80	3	25	--	125
ECCDLO 501X	Department Level Optional Course-1	20	20	20	80	3	--	--	100
ECL501	Digital Communication Lab	--	--	--	--	--	25	25	50
ECL502	Discrete Time Signal Processing Lab	--	--	--	--	--	25	25	50
ECL503	Digital VLSI Lab	--	--	--	--	--	25	25	50
ECL504	Business Communication and Ethics Lab	--	--	--	--	--	25	25	50
ECM501	Mini Project 2A- Embedded System Project	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	150	125	775

Department Level Optional Course-1

Course Code	Department Level Optional Course-1
ECCDLO5011	Digital and IPTV Engineering
ECCDLO5012	Data Compression and Cryptography
ECCDLO5013	IT Infra and Security
ECCDLO5014	Data Structures and Algorithm
ECCDLO5015	Sensor Technology

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC601	Electromagnetics and Antenna	3	--	--	3	--	--	3
ECC602	Computer Communication Networks	3	--	--	3	--	--	3
ECC603	Image Processing and Machine Vision	3	--	--	3	--	--	3
ECC604	Artificial Neural Network and Fuzzy Logic	3	--	--	3	--	--	3
ECCDLO 601X	Department Level Optional Course-2	3	--	--	3	--	--	3
ECL601	Electromagnetics and Antenna Lab	--	2	--	--	1	--	1
ECL602	Computer Communication Networks Lab	--	2	--	--	1	--	1
ECL603	Image Processing and Machine Vision Lab	--	2	--	--	1	--	1
ECL604	Skill Lab: Linux and Networking and Server Configuration	--	4	--	--	2	--	2
ECM601	Mini Project 2B- FPGA based Project	--	4 ^{\$}	--	--	2	--	2
Total		15	14	--	15	07	--	22

\$ Indicates work load of a learner (Not Faculty) for Mini Project 2B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC601	Electromagnetics and Antenna	20	20	20	80	3	--	--	100
ECC602	Computer Communication Networks	20	20	20	80	3	--	--	100
ECC603	Image Processing and Machine Vision	20	20	20	80	3	--	--	100
ECC604	Artificial Neural Network and Fuzzy Logic	20	20	20	80	3	--	--	100
ECCDLO 601X	Department Level Optional Course-2	20	20	20	80	3	--	--	100
ECL601	Electromagnetics and Antenna Lab	--	--	--	--	--	25	25	50
ECL602	Computer Communication Networks Lab	--	--	--	--	--	25	25	50
ECL603	Image Processing and Machine Vision Lab	--	--	--	--	--	25	25	50
ECL604	Skill Lab: Linux and Networking and Server Configuration	--	--	--	--	--	25	25	50
ECM601	Mini Project 2B- FPGA based Project	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	125	125	750

Department Level Optional Course-2

Course Code	Department Level Optional Course-2
ECCDLO6011	Mixed Signal VLSI
ECCDLO6012	Computer Organization and Architecture
ECCDLO6013	Digital Forensic
ECCDLO6014	Database Management System
ECCDLO6015	IoT and Industry 4.0
ECCDLO6016	Radar Engineering

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC501	Digital communication	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC501	Digital communi- cation	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC401 - Engineering Mathematics-IV
ECC404 - Signals and Systems
ECC405 - Principles of Communication Engineering

Course Objectives:

1. To describe the basics of information theory and source coding.
2. To illustrate various error control codes.
3. To describe baseband system.
4. To learn different digital modulation and demodulation techniques

Course Outcomes:

After successful completion of the course student will be able to:

1. Apply the concepts of information theory in source coding.
2. Compare different error control systems and apply various error detection codes.
3. Analyze different error correction codes.
4. Compare various baseband transmission methods for digital signals.
5. Evaluate the performance of optimum baseband detection in the presence of white noise.
6. Compare the performances of different digital modulation techniques

Module No.	Unit No.	Topics	Hrs.
1.0		Information Theory and Source Codes	05
	1.1	Block diagram of digital communication system, Information content of a source symbol, Source entropy, Average information rate, AWGN channel, and Shannon-Hartley channel capacity theorem.	03
	1.2	Introduction of source code, Huffman code, Shannon-Fano code.	02
2.0		Error Control System and Error Detection Codes	03
	2.1	Introduction of error control system, Automatic Retransmission Query (ARQ) system, Types of ARQ systems and comparison, Forward error correction (FEC) system. Comparison between FEC and ARQ.	01
	2.2	Error detection codes: Vertical Redundancy Check (VRC) code, Longitudinal Redundancy Check (VRC) code, Cyclic Redundancy Check (CRC) code and Checksum code.	02
3.0		Error Correction Codes	10
	3.1	Linear block code: Code generation, calculation of minimum Hamming distance, error detection capability, error correction capability, implementation of encoder, error detection, syndrome table, error correction and implementation of decoder.	03
	3.2	Cyclic code: Code generation, calculation of minimum Hamming distance, error detection capability, error correction capability, implementation of encoder, error detection, syndrome table, error correction and implementation of decoder.	03
	3.3	Convolutional code: Generation, path responses, encoder, state transition table, state diagram, tree diagram, trellis diagram, decoding using Viterbi's algorithm.	04
4.0		Baseband Transmission	05
	4.1	Block diagram of baseband transmitter-receiver system, Line codes (RZ and NRZ UniPolar formats, RZ and NRZ Polar formats, NRZ Bipolar format (AMI format), NRZ Manchester format, and Quaternary Polar format). Comparison of line codes with respect to bandwidth, power requirement, synchronization capability, DC level, polarity inversion error and complexity. Power spectral density and spectrum of NRZ Unipolar and Polar formats.	03
	4.2	Inter Symbol Interference (ISI), Inter Channel Interference (ICI). Nyquist criterion for distortionless baseband binary transmission, Nyquist bandwidth and practical bandwidth.	02
5.0		Optimum Detection of Baseband Signal	04
	5.1	Matched filter, Output SNR, Transfer function, Impulse response and Error probability. Integrate and dump receiver, Correlator receiver.	04
6.0		Digital Modulations	12
	6.1	Generation, Detection, Error probability (using signal space representation and Euclidean distance), Bandwidth (using PSD and spectrum except for MSK) and applications of the following modulations: Binary ASK, Binary PSK, Quadrature PSK, Off-Set QPSK, M-ary PSK, Binary FSK, M-ary FSK, 16-ary QASK and MSK.	12
		Total	39

Text Books:

- 1.H. Taub, D. Schilling, and G. Saha-Principles of Communication Systems, Tata Mc- Graw Hill, New Delhi, Third Edition, 2012.
2. Lathi B P, and Ding Z-Modern Digital and Analog Communication Systems, Oxford University Press, Fourth Edition, 2017.
3. Haykin Simon-Digital Communications, John Wiley and Sons, New Delhi, Fourth Edition, 2014.
4. John G. Proakis-Digital Communications, McGraw-Hill, Fourth Edition

Reference Books:

1. Sklar B, and Ray P. K.-Digital Communication: Fundamentals and applications, Pearson,Dorling Kindersley (India), Delhi, Second Edition, 2009.
2. T L Singal-Analog and Digital Communication, Tata Mc-Graw Hill, New Delhi, First Edition,2012.
3. P Ramakrishna Rao-Digital Communication, Tata Mc-Graw Hill, New Delhi, First Edition,2011.
4. K. Sam Shanmugam-Digital and analog communication Systems, John Wiley and sons.
5. Upamanyu Madhow- Fundamentals of Digital Communication- Cambridge University Press
6. W.C. Huffman, Vera Pless- Fundamentals of Error Correcting Codes, Cambridge University Press
7. Graham Wade-Coding Techniques, Palgrave, New York

NPTEL / Swayam Course:

1. <https://nptel.ac.in/courses/108/101/108101113/>
2. <https://nptel.ac.in/courses/108/102/108102096/>
3. <https://nptel.ac.in/courses/108/102/108102120/>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC502	Discrete-Time Signal Processing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC502	Discrete-Time Signal Processing	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC404 Signals & Systems

Course Objectives:

1. To develop a thorough understanding of discrete Fourier transform and its use in spectral analysis and frequency domain filter designing.
2. To design and realize IIR filters and FIR filters, gain an appreciation for the tradeoffs necessary in the filter design and to evaluate the effects of finite word lengths on the filters.
3. To introduce applications of digital signal processing in the field of biomedical and audio signal processing.

Course Outcomes:

After successful completion of the course student will be able to:

1. Recall the system representations and understand the relation between different transforms.
2. Understand the concepts of discrete-time Fourier transform, fast Fourier transform and apply in system analysis.
3. Design digital IIR and FIR filters to satisfy the given specifications and evaluate the frequency response and pole-zero representations to choose a particular filter for the given application.
4. Interpret the different realization structures of Digital IIR and FIR filters.
5. Analyze the impact of hardware limitations on the performance of digital filters.
6. Apply signal processing concepts, algorithms in applications related to the field of biomedical and audio signal processing.

Module No.	Unit No.	Topics	Hrs.
1.0		Discrete Fourier Transform & Fast Fourier Transform	08
	1.1	Discrete Fourier transform (DFT), DFT as a linear transformation, Properties of the DFT, Relationship of the DFT to other transforms, Filtering of long data sequences: Overlap-Save and Overlap-Add Method	05
	1.2	Fast Fourier Transform: Radix-2 Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT	03
2.0		IIR Digital filters	08
	2.1	LTI systems as frequency-selective filters like low pass, high pass, band pass, notch, comb, all-pass filters, and digital resonators, Analog filter approximations: Butterworth, Chebyshev I, Elliptic	03
	2.2	Mapping from s-plane to the z-plane - impulse invariant and bilinear transformation, Design of IIR digital filters (Butterworth and Chebyshev-I) from analog filters using impulse invariant and bilinear transformation techniques, Analog and digital frequency transformations	05
3.0		FIR Digital Filters	09
	3.1	Characteristics of linear phase FIR digital filters, Symmetric and antisymmetric FIR filter, Location of the zeros of linear phase FIR filters, Minimum, maximum and mixed phase systems	04
	3.2	Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackman, Bartlett), Design of FIR filters using Frequency Sampling Technique – Type I low pass filter design, Comparison of IIR and FIR filters	05
4.0		Digital Filter Structures	05
	4.1	Realization structures for FIR systems: Cascade form, Frequency sampling structure, Lattice structure, Computational complexities for N length filter	02
	4.2	Realization structures for IIR systems: Cascade form and parallel form structures, Lattice Ladder structure, Computational complexities for N order filter	03
5.0		Finite Word Length Effects in Digital Filters	05
	4.1	Rounding and truncation errors, Quantization error, Output noise power from a digital system	02
	4.2	Product quantization, Noise model for direct form and cascaded IIR structure (first order), Coefficient quantization error and zero input limit cycle	03
6.0		Applications of Digital Signal Processing	04
	6.1	Application of DSP for ECG and EEG signals analysis.	02
	6.2	Application of DSP for echo cancellation and sub-band coding of speech signal	02
		Total	39

Text Books:

1. Proakis J., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education.
2. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing", A Practical Approach", Pearson Education
3. A Nagoor Kani "Digital Signal Processing", 2nd Edition. Tata Mc Graw Hill Education Private Limited

Reference books

1. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach ", 4th Edition McGraw Hill Education (India) Private Limited, 2013
2. Oppenheim A., Schafer R., Buck J., "Discrete Time Signal Processing", 2nd Edition, Pearson Education, 3rd Edition, 2010
3. L. R. Rabiner and B. Gold, "Theory and Applications of Digital Signal Processing", Prentice-Hall of India, 2006.
4. S Salivahan, C Gnanapriya, "Digital Signal Processing", Mc Graw Hill Education (India) limited, 4th Edition, 2015
5. Monson H Hayes, "Digital Signal Processing", Schaum's Outline Series, 2nd Edition, 2011
6. Rangaraj M. Rangayyan, "Biomedical Signal Analysis- A Case Study Approach", Wiley 2002.

NPTEL / Swayam Course:

1. Course: Digital Signal Processing By Prof. S.C Dutta Roy, IIT Delhi
<http://www.nptelvideos.in/2012/12/digital-signal-processing.html>
2. Course: Digital Signal Processing By Prof. V. M. Gadre , IIT Bombay
<https://nptel.ac.in/courses/108/101/108101174/>
3. Course: Digital Signal Processing By Prof. T. K. Basu , IIT Kharagpur
<https://nptel.ac.in/courses/108/105/108105055/>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC503	Digital VLSI	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC503	Digital VLSI	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC302 – Electronic Devices and Circuits

ECC303 – Digital System Design

ECC403 – Linear Integrated Circuits

Course Objectives:

1. To introduce process flow of VLSI Design.
2. To understand MOSFET operation from VLSI design perspective.
3. To learn VLSI design performance metric and various tradeoffs.
4. To design, implement and verify combinational and sequential logic circuits using various MOS design styles.
5. To provides an exposure to RTL design and programming

Course Outcomes:

After successful completion of the course student will be able to:

1. Know various tools and processes used in VLSI Design.
2. Explain working of various CMOS combinational and sequential circuits used in VLSI Design.
3. Derive expressions for performance parameters of basic building blocks like CMOS inverter.
4. Relate performance parameters with design parameters of VLSI circuits.
5. Select suitable circuit and design style for given application.
6. Design and realize various combinational and sequential circuits for given specifications.

Module No.	Unit No.	Topics	Hrs.
1.0		Review of MOSFET operation and Fabrication	08
	1.1	Overview of VLSI Design Flow, Review of MOSFET operation, MOSFET Capacitances, MOSFET scaling, Short channel effects	03
	1.2	Fabrication process flow of NMOS and CMOS, Lambda based design rules	03
	1.3	Novel MOSFET Architectures FinFET, GAA-FET, CNTFET	02
2.0		Combinational CMOS Logic Circuits	06
	2.1	CMOS inverter operation, Voltage Transfer characteristics (VTC), Noise Margins, Propagation Delay, Power Dissipation, Design of CMOS Inverter, Layout of CMOS Inverter	03
	2.2	Realization of CMOS NAND gate, NOR gate, Complex CMOS Logic Circuits, Layout of CMOS NAND, NOR and complex CMOS circuits	03
3.0		MOS Design Logic Styles	09
	3.1	Static CMOS, Pass Transistor Logic, Transmission Gate, Pseudo NMOS, Dynamic Logic, Domino Logic, NORA, Zipper, C ² MOS	04
	3.2	Setup time, Hold time, clocked CMOS SR Latch, CMOS JK Latch, MS –JK Flip Flop, Edge triggered D-Flip Flop and realization using design styles	03
	3.3	Realization of Shift Register, MUX, Decoder using above design styles ,1-bit full adder	02
4.0		Semiconductor Memories	06
	4.1	ROM array, 6T-SRAM (operation, design strategy, leakage currents, sense amplifier), layout of SRAM	03
	4.2	Operation of 1T and 3T DRAM Cell, NAND and NOR flash memory	03
5.0		Data path and system design issues	06
	5.1	Ripple carry adder, CLA adder, carry save adder, carry select adder, carry skip adder, Array Multiplier	04
	5.2	On chip clock generation and distribution, Interconnect delay model, interconnect scaling and crosstalk	02
6.0		RTL Design	04
	6.1	High Level state machines, RTL design process	02
	6.2	RTL design of Soda dispenser machine, FIR Filter	02
Total			39

Text Books:

1. Sung-Mo Kang and Yusuf Leblebici, “*CMOS Digital Integrated Circuits Analysis and Design*”, Tata McGraw Hill, 3rd Edition, 2012.
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, “*Digital Integrated Circuits: A Design Perspective*”, Pearson Education, 2nd Edition.
3. Frank Vahid, “*Digital Design with RTL design, VHDL and VERILOG*”, John Wiley and Sons Publisher 2011.

Reference Books:

1. Neil H. E. Weste, David Harris and Ayan Banerjee, —*CMOS VLSI Design: A Circuits and Systems Perspective*, Pearson Education, 3rd Edition.
2. John P. Uyemura, “*Introduction to VLSI Circuits and Systems*”, Wiley, Student Edition, 2013.
3. R. Jacob Baker, “*CMOS Circuit Design, Layout and Simulation*”, Wiley, 2nd Edition, 2013

NPTEL / Swayam Course:

1. <https://nptel.ac.in/courses/117/101/117101058/>
2. <https://nptel.ac.in/courses/108/107/108107129/>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on completion of approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-1). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC504	Random Signal Analysis	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC504	Random Signal Analysis	20	20	20	80	03	25	--	125

Course Pre-requisite:

ECC401- Engineering Mathematics IV
ECC404 - Signals and Systems

Course Objectives:

1. To strengthen the foundations of probability
2. To teach continuous and discrete random variables.
3. To explain statistical behavior of one dimensional and two dimensional random variables.
4. To describe the concept of random process which is essential for random signals and systems encountered in Communications and statistical learning.
5. To develop problem solving skills and explain how to make the transition from a real world problem to a probabilistic model.

Course Outcomes:

After successful completion of the course student will be able to:

1. Apply theory of probability in identifying and solving relevant problems.
2. Differentiate continuous and discrete random variables and their distributions.
3. Analyze mean, variance, and distribution function of random variables and functions of random variables.
4. Define a random process, determine the type of the process and find the response of LTI system for WSS process.
5. Explain linear regression algorithms and apply for predictive applications.

Module No.	Unit No.	Topics	Hrs.
1.0		Basic Concepts in Probability	04
	1.1	Definitions of probability, joint, conditional, and total probability, Bayes' theorem, independence of events, binary symmetric communication channel analysis using Bayes' theorem.	
2.0		Introduction to Random Variables	08
	2.1	Continuous, discrete, and mixed random variables, probability density function, probability distribution function, and probability mass function, properties of PDF and CDF	
	2.2	Special distributions- Binomial, Poisson, Uniform, Gaussian and Rayleigh Distributions Mean, variance and moments of random variables	
3.0		Operations on One Random Variable	08
	3.1	Function of a random variable and their distribution and density functions.	
	3.2	Expectation, variance, moments, and characteristic function of random variable.	
	3.3	Transformation of a random variable, Markov and Chebyshev inequality, characteristic functions, moment theorem.	
4.0		Multiple Random Variables and Convergence	08
	4.1	Pairs of random variables, joint CDF and joint PDF.	
	4.2	One function of two random variables; joint moments, covariance and correlation-independent, uncorrelated and orthogonal random variables.	
	4.3	Central limit theorem and its significance	
5.0		Random Processes	06
	5.1	Definitions, statistics of stochastic processes, n^{th} order distribution, second-order properties: mean and autocorrelation, Poisson process, normal processes, SSS, WSS.	
	5.2	Mean and correlation ergodic processes, transmission of WSS through LTI system, introduction to Markov process.	
6.0		Introduction to Statistical Learning and Applications	05
	6.1	Regression and model building, simple linear regression, multiple linear regression, least square estimation of the coefficients, residual calculations.	
	6.2	Applications of simple linear regression in prediction of new observations.	
		Total	39

Text Books:

1. T. Veerarajan, "Probability, Statistics and Random Process", Tata McGraw Hill Education, Third Edition (2018).
2. Athanasios Papoulis and S. Unnikrishna Pillai, "Probability, Random Variables, and Stochastic Processes", Tata McGraw Hill Education
3. Henry Stark & John Woods, "Probability, Statistics, and Random Processes for Engineers, 4th Edition, Pearson Education, 2012

4. Douglas C. Montgomery, Elizabeth A. Peck and G. Geoffrey Vining, "Introduction to linear regression Analysis", student edition, Wiley publications.

Reference Books

1. Scott Miller and Donald Childers, "Probability and Random Processes with Applications to Signal Processing and Communications", Elsevier Publication.
2. Hwei Hsu, "Theory and Problems of Probability, Random Variables, and Random Processes", Schaum's Outline Series, McGraw Hill, 1997.
3. P. Ramesh Babu, "Probability Theory and Random Process", Tata McGraw Hill Education.
4. Alberto Leon Garcia, "Probability and Random Processes for Electrical Engineering", second edition, Pearson education.
5. Daniela Witten, Trevor Hastie, Robert Tibshirani, "An Introduction to Statistical Learning by Gareth James", 7th Edition, Springer 2017.
6. Ronald Walpole, et. al., "Probability and Statistics for Engineers and Scientists", 8th edition, Pearson Education.
7. P. Kousalya, "Probability, Statistics, and Random Processes", Pearson Education.

NPTEL / Swayam Course:

1. Introduction to probability and Statistics, Prof. G. Srinivasan (IIT Madras);
https://onlinecourses.nptel.ac.in/noc21_ma01/preview
2. Probability and Probability Distributions By Dr. P.Nagesh:
https://onlinecourses.swayam2.ac.in/cec21_ma02/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Term Work (25-Marks):

At least 08 Tutorials covering entire syllabus must be given during the "Class Wise Tutorial". Term work assessment must be based on the overall performance of the student with every tutorial graded from time to time. The grades will be converted to marks as per "Credit and Grading System" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5011	Digital and IP TV Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg.					
ECCDLO 5011	Digital and IP TV Engineering	20	20	20	80	03	--	--	100

Prerequisite:

1. Basics of various Television standards and operation
2. TCP/IP Protocol
3. Basics of conventional video camera and standards

Course Objectives:

1. To provide in depth knowledge about Digital Television system
2. To familiarize students' various types of advanced types of Video cameras and Displays
3. To introduce the students to different television standards and applications
4. Acquaintance with HDTV and 3D TV system
5. To familiarize the students to IPTV, Its architecture, Protocols and hardware
6. To Introduce students to IP delivery networks, threats and mitigation

Course Outcomes:

After successful completion of the course student will be able to:

- 1) Understand the working principles of advanced digital television systems.
- 2) Enable to choose or develop an appropriate camcorder and displays based on applications.
- 3) Familiar with current digital TV standards.
- 4) Evaluate the Stereoscopic images and binocular depth perception.
- 5) Acquire knowledge of IPTV and develop hardware and protocols.
- 6) Ability to provide customized IPTV services to end user.

Module No	Unit No	Topics	Hrs
1		Fundamentals of Digital Television	7
	1.1	Fundamentals of colour television, Compatibility, and reverse compatibility, colour perception, Three colour theory, luminance, hue and saturation. Interlaced scanning, Composite video signal	
	1.1	Introduction to Digital TV, Digital TV signals and parameters	
	1.2	Digital TV transmitter and Receiver its merits and demerits	
	1.3	MAC Signals and advanced MAC Signal Transmission	
	1.4	Digitization, Chroma sub sampling, Digital audio compression techniques and video compression techniques MPEG1,MPEG2,H.264,MPEG- 4,AVC,H.265, SMPTE 421M,	
	1.5	Set Top Box with recording	
2		Digital Video Cameras, Displays and Streaming media device	5
	2.1	Colour TV Digital cameras, Camcorders, Handycams, and Digicams	
	2.2	LED, LCD, OLED, PLASMA, Quantum Dot LED Displays	
	2.3	Chromecast	
	2.4	Consumer applications: DVD, Blue ray DVD	
3		Digital TV standards and advanced TV	8
	3.1	DVB-T, and its successors	
	3.2	ISDB -T	
	3.3	ATSC	
	3.4	ISD TV	
	3.5	DTMB	
	3.6	Ultra HDTV	
	3.7	CCTV	
	3.8	Direct to Home TV(DTH)	
	3.9	Smart TV and its functions	
	3.10	3D TV	
4		IPTV	6
	4.1	Introduction to IPTV	
	4.2	IP TV hardware	
	4.3	Features of IPTV	
	4.4	Architecture of IPTV	
	4.5	Bandwidth requirement	
	4.6	IPTV Set top Box, Smart TV comparison	
5		IP TV Protocols and Applications	9
	5.1	Internet Group Management Protocol (IGMP)	
	5.2	Real-Time Streaming Protocol (RTSP)	
	5.3	Real-Time Messaging Protocol (RTMP)	
	5.4	Hypertext Transfer Protocol (HTTP).	
	5.5	Applications of IPTV	

	5.6	IPTV Delivery: Broad cast. Unicast, Multicast	
	5.7	IPTV Streaming: Time Shifted Stream-On -the- fly streaming	
	5.8	experimental framework used for evaluating the classification algorithm	
	5.9	Experimental framework for evaluating the classification algorithm (Self learning) Configuring IPTV to android phone, Tablet, Television and Computer(Self Learning)	
6		IPTV Network Security: Threats and Countermeasures	4
	6.1	Threats on IPTV Delivery Networks, Theft or Abuse of Network Assets, Theft of Service, Theft of IPTV-Related Data, Disruption of Service, Privacy Breach, Compromise of Platform Integrity	
	6.2	Security Issues of IPTV Delivery Networks: Protocols Vulnerabilities, Countering the threats	
	6.3	Advantages and disadvantages of IPTV	
	6.4	Future of IPTV	
Total			39

Textbooks:

1. Television and video Engineering, A. M. Dhake, Tata McGraw Hill Publication.
2. Video Demystified, Kelth jack, Hand book for digital engineers, Newness, Elsevier
3. Digital Television Systems. Marcelo S. Alencar, Cambridge University Press
4. Understanding IPTV, Gilbert Held, CRC Press

Reference Books:

1. The digital evolution of Television, D. Gerbarg, Springer
2. Applications and Usability of interactive TV, Maris Jos Abisolo, Springer
3. IPTV Delivery network, Suliman Mohamed Fati, Saiful Azad, Al-Sakib Khan Pathan, Wiley Publications
4. Television Engineering & Video Systems, R. G. Gupta, McGraw Hill Publication
5. Quantum dot based light emitting diodes, Morteza Sasani Ghamsari, Google book

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDL O5012	Data Compression and Cryptography	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ECCDL O5012	Data Compression and Cryptography	20	20	20	80	03	--	--	100

Course Objectives:

1. Gain a fundamental understanding of data compression methods for text, images, video and audio.
2. Understand the concepts of cryptography and different algorithms to provide system security.

Course Outcomes:

After successful completion of the course student will be able to

1. Apply various compression techniques for text and understand image compression and its standards.
2. Select suitable compression techniques for specified lossless and lossy audio and video applications.
3. Compare between symmetric and asymmetric cryptography and also describe different symmetric cryptographic techniques and standards.
4. Apply number theory concepts to solve the cryptographic problems.
5. Analyze different public key cryptography algorithms and also describe methods that provide the goals for integrity, confidentiality and authentication.
6. Describe system security facilities designed to protect a computer system from security threats and also appreciate ethical issues related to system security.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Data Compression	06
	1.1	Data compression, modelling and coding, Lossless and Lossy Compression, Arithmetic Coding – Decoding, Dictionary Based Compression, Sliding Window Compression: LZ-77, LZ-78, LZW.	
	1.2	Image Compression DCT, JPEG, JPEG – LS, Differential Lossless Compression, DPCM, JPEG – 2000 Standards.	
2.0		Video and Audio Compression	06
	2.1	Video compression: Motion compensation, temporal and spatial prediction, MPEG-4, H.264 encoder and decoder.	
	2.2	Sound, Digital Audio, μ -Law and A-Law Companding, MPEG –4 Audio Layer, Advanced Audio Coding (AAC) standard.	
3.0		Data Security	10
	3.1	Security Goals, Cryptographic Attacks and Techniques	
	3.2	Symmetric Key: Substitution Cipher, Transposition Cipher , Stream and Block Cipher	
	3.3	DES, double DES and triple DES, AES	
4.0		Number Theory	04
	4.1	Prime Numbers, Fermat's and Euler's Theorem.	
	4.2	Chinese Remainder Theorem	
5.0		Asymmetric Key Cryptography	09
	5.1	Principles of Public Key Crypto System, RSA, Key Management, Deffie-Hellman Key Exchange.	
	5.2	Message Integrity, Message Authentication and Hash Functions, SHA, HMAC, Digital Signature Standards.	
6.0		System Security	04
	6.1	Intrusion Detection System, Secure Electronic Transactions.	
	6.2	Firewall Design, Digital Immune systems, Biometric Authentication, Ethical Hacking.	
		Total	39

Textbooks:

1. Khalid Sayood , 3rd Edition, [Introduction to Data Compression], Morgan Kauffman
2. Mark Nelson, Jean-Loup Gailly, [The Data Compression Book], 2nd edition, BPB Publications
3. William Stallings , [Cryptography and Network Security Principles and Practices 5th Edition], Pearson Education.
4. Behrouz A. Forouzan, [Cryptography and Network Security], Tata McGraw-Hill.

Reference Books:

1. David Salomon, [Data Compression: The Complete Reference], Springer.
2. Matt Bishop, [Computer Security Art and Science], Addison-Wesley.
3. Bernard Menesez, [Network Security and Cryptography] Delmar Cengage Learning, 7th Edition.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5013	IT Infra & Security	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 5013	IT Infra & Security	20	20	20	80	03	--	--	100

Course prerequisite:

- **Principles of Communication**

Course Objectives:

1. To introduce basic fundamentals of IT Infrastructure and its Management.
2. To develop underlying principles of infrastructure security.
3. To explore software vulnerabilities and attacks.
4. To introduce the protection mechanisms for operating systems and database security.
5. To explore the security aspects of wireless network infrastructure and protocols.
6. To investigate the different attacks on Web Applications and Web services.

Course Outcomes: Students will be able to:

1. Understand IT Infrastructure and its Management.
2. Understand the concept of Information securities.
3. Summarize the concepts of vulnerabilities, attacks and protection mechanisms.
4. Analyze software vulnerabilities and attacks on databases and operating systems.
5. Explain the need for security protocols in the context of wireless communication.
6. Analyze the different attacks on Open Web Applications and Web services.

Module No.	Unit No.	Topics	Hrs
1.0		Overview of Networks and IT Infrastructure	09
	1.1	Overview of OSI and TCP/ IP Networks, introduction to IP Addressing scheme, introduction to Networking Components	
	1.2	Information Technology, Design Issues of IT Organizations and IT Infrastructure, Information System Design Process, IT Infrastructure Management, Challenges in IT Infrastructure Management, Determining Customers, Requirements, Security controls and safeguards, IT security Plans.	
2.0		Introduction to Information Security	06
		Cyber-attacks, Vulnerabilities, Defense Strategies and Techniques, Authentication Methods- Password, Token and Biometric, Access Control Policies and Models (DAC, MAC, RBAC, BIBA, Bell La Padula), Authentication and Access Control Services- RADIUS, TACACS, and TACACS+	
3.0		Software Vulnerabilities	04
		Buffer overflow, Format String, Cross-Site Scripting, SQL Injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits	
4.0		Operating System and Database Security	08
	4.1	Introduction operating system security, system security planning, Application security, Linux/ Unix security, Windows, security, Security Maintenance,	
	4.2	Database Security Requirements, Reliability and Integrity, Sensitive Data, Inference Attacks, Multilevel Database Security	
5.0		Wireless Security	05
		The need for Wireless Network Security, Attacks on Wireless Networks, Security services, WEP & WPA protocols, Mobile IP, Virtual Private Network (VPN): PPTP, L2TP, IPSec	
6.0		Web Security	07
		Introduction: Transport Protocol and Data Formats, Web Browser, Threat Model Authenticated Sessions: Cookie Poisoning, Cookies and Privacy, Making Ends Meet Code Origin Policies, Cross-Site Scripting: Cookie Stealing, Defending against XSS, Cross-Site Request Forgery, JavaScript Hijacking	
		Total	39

Text Books:

1. Gupta, “IT Infrastructure & Its Management”, First Edition, Tata McGraw-Hill Education.
2. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
3. Computer Security, Dieter Gollmann, Third Edition, Wiley Publications.
- 4 Data Communications and Networking, Forouzan, Fourth Edition, Mc Graw Hill Publication
- 5 Wireless Networks, P. Nicopolitidis, M.S. Obaidat, G.I Papadimitriou, A.S Pomportsis, Wiley Publications

Reference Books:

1. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education
2. CCNA Security Study Guide, Tim Boyle, Wiley Publications
3. Introduction to Computer Security, Matt Bishop, Pearson.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5014	Data Structure & Algorithm	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 5014	Data Structure & Algorithm	20	20	20	80	03	--	--	100

Course pre-requisite:

ECL404 Skill Lab: Python Programming

Course Objectives:

The course aims:

1. To Introduce the fundamental knowledge & need of Data Structures.
2. To Abstract the concept of Algorithm and these concepts are useful in problem solving.
3. To Implement fundamental knowledge and applications of Stack, Queue, Linked List, Trees, Graphs etc.
4. To Understand the working of different Sorting, Searching & Hashing techniques.
5. To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures.

Course Outcome:

After successful completion of the course the student will: -

1. Compare functions using asymptotic analysis and describe the relative merits of worst-, average-, and best-case analysis.
2. Apply various operations on Stack and Queue.
3. Ability to demonstrate the operation of Linked list.
4. Ability to demonstrate and apply Trees & Graph data structures.
5. Become familiar with various Sorting and Searching Algorithms and their performance characteristics.
6. Describe the hash function and concepts of collision and its resolution methods

Module No.	Unit No.	Topics	Hrs.
		Prerequisite: Control Structures, Arrays, Recursion, Pointers, Structures, Memory Allocation Techniques, Self-referential structures.	
1.0		Introduction to Data Structure & Algorithm	5
	1.1	Introduction to Data Structures, Concept of ADT, Types of Data Structures-Linear and Nonlinear, Operations on Data Structures.	
	1.2	Algorithm: Performance characteristics of algorithm, Importance of Algorithm Analysis, Complexity of an Algorithm, Introduction to Asymptotic Analysis and Notations.	
2.0		Stack & Queue	8
	2.1	Introduction to Stack, ADT of Stack, Operations on Stack, Array Implementation of Stack	
	2.2	Applications of Stack- Infix to Postfix Expression Conversion, Infix Expression to Prefix Expression Conversion, Postfix Expression Evaluation	
	2.3	Introduction to Queue, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Introduction to Double Ended Queue	
	2.4	Applications of various types of Queue	
		Self-Learning Topic: Well form-ness of Parenthesis using Stack	
3.0		Linked List	7
	3.1	Introduction, Linked List v/s Array, Representation of Linked List, Types of Linked List - Singly Linked List, Doubly Linked List	
	3.2	Operations on Singly Linked List and Doubly Linked List	
	3.3	Singly Linked List Application-Polynomial Representation and Addition, Doubly Linked List Application	
		Self-Learning Topic: Stack and Queue using Singly Linked List	
4.0		Trees & Graph	9
	4.1	Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree,	
	4.2	Applications of Binary Tree- Expression Tree, Huffman Encoding.	
	4.3	Graph: Introduction, Graph Terminology, Memory Representation of Graph, Operations Performed on Graph.	
	4.4	Graph Traversal, Breadth First Search, Depth First Search, Applications of the Graph, Shortest Path, Minimum Spanning Tree.	
5.0		Searching & Sorting	6
	5.1	Searching: Sequential Search, Index Sequential Search, Binary Search	
	5.2	Sorting: Bubble Sort, Quick Sort, Merge Sort	
		Self-Learning Topic: Selection Sort, Insertion Sort	
6.0		Hashing	4
	6.1	Hashing-Concept, Hash Functions, Common hashing functions	
	6.2	Collision resolution Techniques	
		Total	39

Text Books:

1. Jean Paul Tremblay, P. G. Sorenson, “Introduction to Data Structure and its Applications”, McGraw-Hill Higher Education
2. “Fundamentals of Computer Algorithms” Ellis Horowitz, Sartaj Sahani and Sanguthevar Rajasekaran, Second Edition, Universities Press (India) Pvt. Ltd.
3. “Learning with Python” Allen Downey, Jeffrey Elkner, Chris Meyers, Dreamtech Press

Reference Books:

1. Jean Paul Tremblay, Paul G. Sorenson; An introduction to data structures with applications; Tata McGrawHill; 1984
2. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, “Algorithms”, Tata McGrawHill Edition.

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 5015	Sensor Technology	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 5015	Sensor Technology	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. FEC202 – Engineering Physics-II
2. ECC302 -- Electronic Devices & Circuits
3. ECC403 - Linear Integrated Circuits

Course Objectives:

1. To understand various physical parameters and its sensing techniques
2. To familiarize about MEMS sensors and Actuators
3. To introduce wireless sensing technologies
4. To develop understanding about signal conditioning using ADC and DAC
5. To provide insight into various sensor applications

Course Outcome:

After successful completion of the course student will be able to

1. Understand the transduction principal of various sensors.
2. Select sensors suitable for required application
3. Analyze wireless sensing techniques
4. Design the data acquisition system
5. Identify signal conditioning method for particular application
6. Create an application using various sensor technologies

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction	03
	1.1	Classification of Sensors : The sensors are classified with criteria like primary physical quantity to be sensed , transduction principle, material and technology used and application	
	1.2	Criteria to choose a Sensor: Accuracy, Environmental condition, Range, Calibration, Resolution , Cost and Repeatability	
	1.3	Digital sensors : Principle and its advantage over analog sensors	
	1.4	Smart Sensors: Low-power, Self –diagnostic and Self- calibration	
2.0		Types of Sensors	09
	2.1	Temperature Sensors : RTD, Thermocouple and Thermistors sensor	
	2.2	Proximity Sensors : Inductive (LVDT), Capacitive, Photoelectric and Ultrasonic sensors	
	2.3	Chemical Sensors : Gas , Smoke, Conductivity and pH sensor	
	2.4	Other Sensors : Optical, Infrared (IR), Sound, Motion , Pressure , Level , Moisture, Humidity, Laser , Image and GPS sensor	
3.0		MEMS Sensors and Actuators	06
	3.1	MEMS SENSORS: General design methodology, techniques for sensing, Pressure sensor , Mass Flow sensor , Acceleration sensor , Angular Rate sensor and Gyroscopes, Micro machined microphones, Chemical sensors, Taguchi Gas sensor, Combustible Gas sensors	
	3.2	MEMS ACTUATORS: Techniques for actuation, Digital Micro mirror Device, Micro Machined Valves	
4.0		Wireless Sensing Technologies	05
	4.1	Bluetooth: Concepts of Pico net, Scatter net, Link types, Network connection establishments	
	4.2	ZigBee: components, architecture, network topologies	
	4.3	Ultra Wide Band (UWB), Near Field Communication (NFC) and RFID: technical requirements, components and characteristics	
	4.4	WLAN (WiFi) : WLAN Equipment, WLAN topologies , IEEE 802.11 Architecture	
5.0		Data Acquisition and Signal Conditioning	08
	5.1	Fundamentals of Data Acquisition: Analog and Digital data acquisition system with different configurations, Data loggers, Noise and interference	
	5.2	Signal Conditioning : Wheatstone Bridge, Flash ADC, R2R DAC	
	5.3	Utilization of Signal conditioning circuits for Temperature, Pressure, Optical, Strain gauges, Displacement and piezoelectric Transducers	
6.0		Sensor Applications	08
	6.1	Onboard Automobile sensing system, Home appliances sensors, Aerospace Sensors, Sensors for Environmental Monitoring, Biomedical Sensing Applications	
	6.2	Radio sensors for industrial applications, Radio Astronomy, Remote Sensing, Ground Penetrating Radars, Underwater sensing, LIDAR	
		Total	39

Textbooks:

1. D.V.S. Murthy, “Transducers and Instrumentation”, PHI Learning, 2nd Edition, 2013.
2. D. Patranabis – Sensor and Transducers (2e) Prentice Hall, New Delhi, 2003
3. Antti V. Raisanen, Arto Lehto, “Radio Engineering for Wireless Communication and Sensor Applications”, Artech House mobile communications series, USA, 2003.

4. Sensors and Signal Conditioning, Ramon Pallas Areny, John G. Webster, 2nd edition, John Wiley and Sons, 2000.
5. Vijay K. Garg, “Wireless Communication and Networking”, Morgan -Kaufmann Series in Networking, Elsevier, 2010.

Reference Books:

1. An Introduction to Microelectromechanical Systems Engineering, Nadim Maluf, Kirt Williams, Artech House, 2004.
2. Micro Electro Mechanical System Design, James J. Allen, Taylor and Francis, 2005
3. A.K. Sawhney, “A Course in Electrical and Electronic Measurements and Instrumentation”, Dhanpatrai & Co., 19th Edition, 2011.
4. Nathan Ida, “Sensors, Actuators and their Interfaces: A Multidisciplinary Introduction”, Second Edition, IET Control, Robotics and Sensors Series 127, 2020
5. Instrumentation Devices and System, C.S. Rangan, G.R. Sarma, V.S. Mani, TMH, 1997.
6. Jacob Fraden Handbook of Modern Sensors Physics, Designs, and Applications Fourth Edition, Springer, 2010.

NPTEL / Swayam Course :

<https://nptel.ac.in/courses/108/108/108108147/> <https://www.youtube.com/watch?v=vjhp0zTXEsc>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL501	Digital Communication Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL501	Digital communication Lab	--	--	--	--	25	25	50

Course objectives:

1. To learn source coding and error control coding techniques
2. To compare different line coding methods
3. To distinguish various digital modulations
4. To use different simulation tools for digital communication applications

Course outcomes:

After the successful completion of the course student will be able to

1. Compare various source coding schemes
2. Design and implement different error detection codes
3. Design and implement different error correction codes
4. Compare various line coding techniques
5. Illustrate the impulse response of a matched filter for optimum detection
6. Demonstrate various digital modulation techniques

Suggested list of experiments: (Course teacher can design their own experiments based on the prescribed syllabus)

1. Huffman code generation
2. Shannon-Fano code generation
3. Vertical redundancy Check (VRC) code generation and error detection
4. Horizontal Redundancy Check (HRC) code generation and error detection
5. Cyclic redundancy Check (CRC) code generation and error detection
6. Checksum code generation and error detection
7. Compare the performances of HRC and Checksum
8. Linear block code generation and error detection
9. Error detection and correction using Hamming code virtual lab http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/comp_networks_sm/labs/exp1/index.php
10. Cyclic code generation and error detection
11. Convolutional code generation

12. Line Codes generation and performance comparison
13. Spectrum of line codes (NRZ unipolar and polar)
14. Impulse responses of ideal (Nyquist filter) and practical (Raised cosine filter) solution for zero ISI
15. Matched filter impulse response for a given input
16. Generation (and detection) of Binary ASK
17. Generation (and detection) of Binary PSK
18. Generation (and detection) of Binary FSK
19. Generation (and detection) of QPSK
20. Generation (and detection) of M-ary PSK
21. Generation (and detection) of M-ary FSK
22. Generation (and detection) of 16-ary QASK
23. Generation (and detection) of MSK

Term Work, Practical and Oral:

At least 8 experiments covering the entire syllabus must be given “**Batch Wise**”. The experiments can be conducted with the help of simulation tool (preferably open source) and breadboard and components. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments graded from time to time. The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all the 8 experiments for examination.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL502	Discrete-Time Signal Processing Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL502	Discrete-Time Signal Processing Laboratory	--	--	--	--	25	25	50

Course objectives:

1. To carryout basic discrete time signal processing operations.
2. To implement and design FIR filters and IIR filters.
3. To implement applications related to the field of biomedical signal processing and audio signal processing.

Course outcomes:

Learners will be able to ...

1. Perform basic discrete time signal processing operations such as Linear Convolution, Circular Convolution, Auto Correlation, Cross Correlation, etc. and interpret the results.
2. Demonstrate their ability towards interpreting and performing frequency analysis of different discrete time sequences and systems.
3. Design and implement the FIR and IIR Filters for given specifications.
4. Implement and analyse applications related to the field of biomedical signal processing and audio signal processing.

Suggested list of experiments:

- 1) To perform linear convolution of two signals, auto correlation of non-periodic signals, periodic signals and random noise and interpret the results obtained.
- 2) To linearly convolve swept frequency sinusoidal wave with LPF and HPF impulse response filters in time domain and interpret the results obtained.

- 3) To obtain cross correlation of a signal with its delayed and attenuated version (Concept of radar signal processing).
- 4) To perform block convolution using overlap - add method and overlap-save method.
- 5) To determine impulse, magnitude, phase response and pole-zero plot of given transfer functions.
- 6) To perform circular convolution and linear convolution of two sequences using DFT.
- 7) To perform the DFT of DT sequence and sketch its magnitude and phase spectrum or To Generate a discrete time signal having minimum three frequencies and analyse its frequency spectrum.
- 8) To study the effect of frequency resolution and zero padding.
- 9) DFT based spectral analysis to detect the signal buried in noise.
- 10) To perform denoising of a speech signal using circular convolution.
- 11) Design of IIR digital filters and use the designed filter to filter an input signal which has both low and high frequency components or real-world signal like ECG/EEG, speech signal etc).
- 12) Design a notch filter to suppress the power supply hum in audio signals.
- 13) Design a comb filter to suppress 50Hz hum in biomedical signals.
- 14) Design of FIR filter using windowing method and use the designed filter to filter an input signal which has both low and high frequency components or real-world signal like ECG/EEG, speech signal etc.
- 15) Design of FIR filter using frequency sampling technique.
- 16) Design of minimum phase, maximum phase and mixed phase systems.
- 17) To verify the location of zeros in symmetric and antisymmetric FIR filters.
- 18) To reconstruct DT signals contaminated with sinusoidal interference using FIR filters.
- 19) To realise an IIR filter in cascade and parallel form.
- 20) To obtain lattice parameters of a given transfer function (FIR and IIR systems).
- 21) To perform coefficient quantisation using truncation and rounding.
- 22) To study the effect of coefficient quantisation on the frequency response of an IIR filter.
- 23) To study the effect of coefficient quantisation on the frequency response of an FIR filter.
- 24) To investigate the behaviour of limit cycle in an IIR system.
- 25) To generate the ECG signal and detect the characteristic points.
- 26) Classification of ECG signals.
- 27) To read an ECG signal and separate the QRS Complex.
- 28) To filter out the noise in an ECG signal using Spectral subtraction.
- 29) To extract delta, theta, alpha, sigma, and beta waveforms from EEG signal.
- 30) Perform sub-band coding on speech signal.
- 31) To generate Echo, Reverberation, Flanging effects in a sound signal.
- 32) Musical tone generation.
- 33) DTMF tone generation and detection.
- 34) Echo cancellation.

Also check

Virtual Laboratory <http://vlabs.iitkgp.ernet.in/dsp/#> for demonstration of concepts like DFT and its inverse, FIR filter using windowing method etc

Term Work:

At least 08 experiments covering the entire syllabus must be given “Batch Wise” and implemented using any software namely C, Python, Scilab, Matlab, Octave, etc. The experiments should be set to have well predefined inference and conclusion. Application oriented one course-project can be conducted for maximum batch of four students. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.

The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and averaged. Based on above scheme, grading and term work assessment should be done. Practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all 08 experiments for examination.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL503	Digital VLSI Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL503	Digital VLSI Lab	--	--	--	--	25	25	50

Course objectives:

1. To become familiar with open source circuit simulation tools like Ngspice, Magic etc.
2. To perform various type of analysis of combinational and sequential CMOS circuits
3. To evaluate performance of given combinational and sequential CMOS circuits
4. To design, implement and verify combinational and sequential CMOS circuits using open source VLSI design tools.

Course outcomes:

After the successful completion of the course student will be able to

1. Write spice code for given combinational and sequential CMOS circuits.
2. Perform various analysis like operating point, dc, transient etc of given CMOS circuits.
3. Evaluate performance of given CMOS circuits.
4. Draw layout of given CMOS circuit and also able extract various parasitic using open source layout tool like Magic.
5. Design, simulate, and verify CMOS circuit for given specifications.

Suggested list of experiments: (Course teacher can design their own experiments based on the prescribed syllabus)

1. Constant Voltage and Constant field MOSFET scaling
2. Layout of MOSFET and extraction of parasitic capacitances
3. Voltage transfer characteristics of CMOS inverter and calculation of Noise Margin and static power
4. Transient Analysis of CMOS inverter and calculation of t_{pHL} , t_{pLH} , t_r , t_f , average power
5. Design of CMOS inverter for given specifications
6. Layout of CMOS inverter and comparison of pre layout and post layout performance.
7. Voltage transfer characteristics of 2 input NAND/NOR gate and calculation of noise margins and validation using equivalent inverter approach.
8. Transient Analysis of 2 input NAND/NOR CMOS gate and calculation of t_{pHL} , t_{pLH} , t_r , t_f , average power and validation using equivalent inverter approach.

9. Layout of 2 input CMOS NAND/NOR gate and comparison of pre layout and post layout performance.
10. Static and transient analysis of Complex CMOS gate.
11. Layout of complex CMOS gate using euler path.
12. Implementation of various combinational and sequential circuits using different design styles.
13. Design and implementation of NAND based and NOR based ROM array.
14. Performance analysis of 6T-SRAM Cell
15. Design of 6T SRAM cell robust read and write operation.
16. Performance analysis of 1T and 3T DRAM Cell
17. RTL design of Soda dispenser machine
18. RTL design of FIR Filter

Link for virtual lab

<http://www.vlsi-iitg.vlabs.ac.in>

Term Work, Practical and Oral:

At least 8 experiments (at least three experiments on layout) covering the entire syllabus must be given “**Batch Wise**”. The experiments can be conducted with the help of simulation tool (preferably. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments graded from time to time. The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all the 8 experiments for examination.

Course Code	Course Name	Teaching scheme			Credit assigned			
ECL504	Professional Communication & Ethics-II	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		--	2*+ 2 Hours (Batch-wise)	--	--	2	--	02

***Theory class to be conducted for full class.**

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Internal Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ECL504	Professional Communication & Ethics-II (abbreviated PCE-II)	--	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
ECL504	Business Communication & Ethics	02
Course Rationale	This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.	
Course Objectives	- To discern and develop an effective style of writing important technical/business documents. - To investigate possible resources and plan a successful job campaign. - To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement. - To develop creative and impactful presentation skills. - To analyze personal traits, interests, values, aptitudes and skills. - To understand the importance of integrity and develop a personal code of ethics.	

Course Outcomes	Learner will be able to... • plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles. • strategize their personal and professional skills to build a professional image and meet the demands of the industry. • emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations. • deliver persuasive and professional presentations. • develop creative thinking and interpersonal skills required for effective professional communication. • apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Module	Contents	Hours
1	ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL) 1.1 Purpose and Classification of Reports: Classification on the basis of: • Subject Matter (Technology, Accounting, Finance, Marketing, etc.) • Time Interval (Periodic, One-time, Special) • Function (Informational, Analytical, etc.) • Physical Factors (Memorandum, Letter, Short & Long) 1.2. Parts of a Long Formal Report: • Prefatory Parts (Front Matter) • Report Proper (Main Body) • Appended Parts (Back Matter) 1.3. Language and Style of Reports • Tense, Person & Voice of Reports • Numbering Style of Chapters, Sections, Figures, Tables and Equations • Referencing Styles in APA & MLA Format • Proofreading through Plagiarism Checkers 1.4. Definition, Purpose & Types of Proposals • Solicited (in conformance with RFP) & Unsolicited Proposals • Types (Short and Long proposals) 1.5. Parts of a Proposal • Elements • Scope and Limitations • Conclusion	06

	1.6. Technical Paper Writing • Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References) • Language and Formatting • Referencing in IEEE Format	
2	EMPLOYMENT SKILLS 2.1. Cover Letter & Resume • Parts and Content of a Cover Letter • Difference between Bio-data, Resume & CV • Essential Parts of a Resume • Types of Resume (Chronological, Functional & Combination) 2.2 Statement of Purpose • Importance of SOP • Tips for Writing an Effective SOP 2.3 Verbal Aptitude Test • Modelled on CAT, GRE, GMAT exams 2.4. Group Discussions • Purpose of a GD • Parameters of Evaluating a GD • Types of GDs (Normal, Case-based & Role Plays) • GD Etiquettes 2.5. Personal Interviews • Planning and Preparation • Types of Questions • Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) • Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	06
3	BUSINESS MEETINGS 1.1. Conducting Business Meetings • Types of Meetings • Roles and Responsibilities of Chairperson, Secretary and Members • Meeting Etiquette 3.2. Documentation • Notice • Agenda • Minutes	02

4	TECHNICAL/ BUSINESS PRESENTATIONS 1.1 Effective Presentation Strategies • Defining Purpose • Analyzing Audience, Location and Event • Gathering, Selecting &Arranging Material • Structuring a Presentation • Making Effective Slides • Types of Presentations Aids • Closing a Presentation • Platform skills 1.2 Group Presentations • Sharing Responsibility in a Team • Building the contents and visuals together • Transition Phases	02
5	INTERPERSONAL SKILLS 1.1. Interpersonal Skills • Emotional Intelligence • Leadership & Motivation • Conflict Management & Negotiation • Time Management • Assertiveness • Decision Making 5.2 Start-up Skills • Financial Literacy • Risk Assessment • Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	08
6	CORPORATE ETHICS 6.1Intellectual Property Rights • Copyrights • Trademarks • Patents • Industrial Designs • Geographical Indications • Integrated Circuits • Trade Secrets (Undisclosed Information) 6.2 Case Studies • Cases related to Business/ Corporate Ethics	02

List of assignments:

(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal

3. Meeting Documentation
4. Writing a Technical Paper/ Analyzing a Published Technical Paper
5. Writing a SOP
6. IPR
7. Interpersonal Skills
8. Aptitude test (Verbal Ability)

Note:

1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end-semester presentation based on the book report.

Assessment:

Term Work:

Term work shall consist of minimum 8 experiments.

The distribution of marks for term work shall be as follows:

Assignment	: 10 Marks
Attendance	: 5 Marks
Presentation slides	: 5 Marks
Book Report (hard copy)	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal oral:

Oral Examination will be based on a GD & the Project/Book Report presentation.

Group Discussion	: 10 marks
Project Presentation	: 10 Marks
Group Dynamics	: 5 Marks

Books Recommended:

Textbooks and Reference books:

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition.* Boston, MA: McGraw-Hill.
2. Bovée, C. L., & Thill, J. V. (2021). *Business communication today.* Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace.* Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011). *Personal development for life and work.* Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour.* Harlow,

England: Pearson.

6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
8. Sanjay Kumar & PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM501	Mini Project 2A: Embedded System Project	--	04 ^{\$}	--	--	02	--	02

\$ Indicates work load of a learner (Not Faculty) for Mini Project 2A. Faculty Load: 1 hour per week per four groups.

Subject Code	Subject Name	Examination Scheme						
		Theory Marks						
		Internal Assessment			End Sem. Exam	Term Work	Practical and Oral	Total
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECM501	Mini Project 2A: Embedded System Project	--	--	--	--	25	25	50

Course Pre-requisite:

1. ECC402- Microcontrollers
2. ECC403- Linear Integrated Circuits
3. ECM401- Mini Project 1B: Arduino & Raspberry Pi based Projects

Course Objectives

1. To develop background knowledge Embedded Systems.
2. To understand designing of embedded systems.
3. To choose proper microcontroller for Embedded systems
4. To understand use of wireless sensors/communications with Embedded systems
5. To understand communication techniques.
6. To write programs for embedded systems and real time operating systems /IoT

Course Outcomes

After successful completion of the course, the student will be able to

1. Understand the embedded systems with design metrics.
2. Understand microcontrollers and programming in Embedded C.
3. Implementation of Embedded systems with different sensors and peripherals as IoT.
4. Implementation of Embedded systems with different communication protocols as IoT.
5. Analyze concepts of Real time operating systems.
6. Design embedded system applications using sensors, peripherals and RTOS

A. Guideline to maintain quality of mini project are as follows :

1. To achieve proper selection of Mini Projects. Students should do survey of different microcontroller board from given microcontroller series, tools and identify which is most suitable for their selected topic. They should consult with their Guide/Mentors / Internal committee to finalize it.
2. Students shall submit implementation plan in the form of Smart Report/Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
3. A log book to be prepared by each group, wherein group can record weekly work progress. Guide/ supervisor will verify it and will put notes/comments.

4. Guide/supervisor guidance is very much important during mini project activities; however, focus shall be on self-learning.
5. The solution to be verified with standard tools and procedures and report to be compiled in standard format of University of Mumbai.
6. **Suggested steps for mini project selection and implementation**
 - i. Mini project should be completely microcontroller based
 - ii. Follow these steps
 - a) Take specification, using these specifications design project.
 - b) Select proper microcontroller board considering features and requirements of project.
 - c) Program it using Embedded C and perform verification of each module (sensors/communication protocol)
 - d) Test Functional Simulation and verify it using simulation tool.
 - e) Make hardware connection on GPP of peripherals with microcontroller board and execute the program.
 - f) Troubleshoot if not get expected result.

B. Project Topic selection and approval :-

1. The group may be of **maximum FOUR (04)** students.
2. Topic selection and approval by **2 Expert** faculty from department at the start of semester
3. **Log Book** to be prepared for each group to record the work progress in terms of milestones per week by students. Weekly comment, remarks to be put by guiding faculty. Both students and faculty will put signature in it per week. The log book can be managed **online** with proper authentication method using google sheets/forms or open source project management software.

C. Project Report Format:

1. Report should not exceed **30 pages**. Simply staple it to discourage use of plastic.
2. Report must contain block diagram, circuit diagram, screenshot of outputs and datasheets of microcontrollers and peripherals (Include **only required** information pages).
3. The recommended report writing format is in **LaTeX**.
(<https://youtu.be/YLm3sXIKpHQ>)

Term Work:

1. Term Work evaluation and marking scheme:

- a. The review/ progress monitoring committee shall be constituted by Head of Departments of each institute.
- b. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- c. At end of semester the above 2 expert faculty who have approved the topic will internally **evaluate the performance**.
- d. Students have to give presentation and demonstration on the Embedded Systems Mini Project- 2-A at end of semester before submission to above experts.
- e. In the evaluation each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed. Based upon it the marks will be awarded to student.

f. Distribution of 25 Marks scheme is as follows:

- i. Marks awarded by guide/supervisor based on log book and output : 10
- ii. Marks awarded by review committee : 10
- iii. Quality of Project report : 05

2. Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and **External Examiners preferably from industry or research organisations** having experience of more than five years approved by head of Institution.

Students shall be motivated to present their mini project work done

- Participate in Project Competition
- Publish paper in Conferences/Journals.

Module No.	Unit No.	Detailed Content	Hours
1		Introduction	8
	1.1	Definition of Embedded System, Embedded Systems Vs General Computing Systems, Classification, Major Application Areas. Characteristics and quality attributes (Design Metric) of embedded system.	
	1.2	Identification of Project Title	
2		Controller boards and Programming – Embedded C	8
	2.1	ARM LPC 21XX (2148), STM32 boards and Texas MSP 430 lunchbox/ Tiva C board and PIC/PSoc*	
	2.2	Comparison of C and embedded C, Data Types, Variable, Storage Classes, Bit operation, Arrays, Strings, Structure and unions, Classifier	
	2.3	Exercise: Identify the suitable board required for the particular application with respect to design metrics. (Hint: check clock frequency (speed), memory (program and data), no. of ports for peripherals, timers/counters and serial communication requirement for project)	
	2.4	Suggested Way to Identify : https://predictabledesigns.com/how-to-select-the-microcontroller-for-your-new-product/	
3		Interfacing Sensors and peripherals using Embedded C	10
	3.1	Sensors and Signal Conditioning Circuits amplifiers /attenuators /filters /comparators/ADC and DAC), Interfacing with GLCD/TFT display, Relays and Drivers for interfacing Motors (DC and stepper)	
	3.2	Interfacing with BLDC motors and drivers, USB/HDMI camera interfacing	
	3.3	Exercise : Understand the Interfacing requirement like drivers, signal condition circuits for sensors, etc. for the selected application	
	3.4	Study Material : For LCD interfacing with MSP430 LaunchPad https://microcontrollerslab.com/lcd-interfacing-msp430-launchpad/#:~:text=LCD%20interfacing%20with%20MSP430%20microcontroller,Now%20I%20will&text=It%20requires%205%20volts%20dc,and%20second%20pin%20is%20vcc.	
4		Communication with programming in Embedded C	10
	4.1	Serial communication, CAN bus, I2C, MOD bus, SPI	
	4.2	Interfacing with Wi-Fi, Bluetooth, ZigBee, LoRa, RFID and putting data on IoT	
	4.3	Interfacing with GSM module, GPS module, SD card	
	4.4	Exercise: Understand Communication requirement for selected application and test it	

	4.5	Study Material : Serial Communication Interface: STM32: https://controllerstech.com/serial-transmission-in-stm32/#:~:text=Serial%20Transmission%20in%20Stm32&text=UART%20is%20widely%20used%20for,amongst%20which%20communication%20is%20done . LPC2148: https://www.electronicwings.com/arm7/lpc2148-uart0 MSP430: https://www.ti.com/lit/ml/slap117/slap117.pdf	
5		Real Time Operating Systems[RTOS]	08
	5.1	Operating system basics , Types of OS , Tasks, process, Threads	
	5.2	Multiprocessing and ,Multitasking , Task scheduling	
	5.3	RTLinux/ Free RTOS and Mbed OS , Implementation with RTOS	
6		Cloud/Web server	08
	6.1	Implementation on web server ,	
	6.2	Thingspeak, AWS cloud platform for IoT based programming and modelling	
	6.3	Exercise : perform ESP8266 interface with microcontroller	
	6.4	Study Material : STM32: https://circuitdigest.com/microcontroller-projects/interfacing-esp8266-with-stm32f103c8-stm32-to-create-a-webserver LPC2148: https://circuitdigest.com/microcontroller-projects/iot-based-ARM7-LPC2148-webserver-to-control-an-led MSP430: https://circuitdigest.com/microcontroller-projects/sending-email-using-msp430-and-esp8266	
Total			52

NOTE:

* **Advanced Microcontroller:** Like PSoc and PIC may be used as per the student's intellectual ability and strength.

** **Module 5 and 6 (RTOS and Cloud/Web Server):** Can be included by Guide /supervisor /Mentor depending upon need and scope of the project for selected topic and its application.

Textbooks:

1. Shibu K.V, "Introduction to Embedded Systems", Mc Graw Hill, 2nd edition.
2. Frank Vahid, and Tony Givargis, "Embedded System Design: A unified Hardware/Software Introduction", Wiley Publication.
3. Raj Kamal, "Embedded Systems Architecture, Programming and design", Tata MCgraw-Hill Publication.
4. Dr. K.V.K.K. Prasad, "Embedded Real Time Systems: Concepts, Design & Programming", Dreamtech Publication.
5. Iyer, Gupta, "Embedded real systems Programming", TMH
6. David Simon, "Embedded systems software primer", Pearson
7. Andrew Sloss, Dominic Symes and Chris Wright, "ARM_System_Developers_Guide-Designing_and_Optimizing_System_Software" Elsevier and Morgan Kaufmann Publishers.
8. Michel J Pont "Embedded C" Pearson

Suggested Software tools:

1. Tinkercad : <https://www.tinkercad.com/>
2. Proteus software
3. KEIL for ARM LPC 2148
4. **STM32Cube software**

5. MSP Flasher - Command Line Programmer
6. msp430 code composer studio

Online Repository:

1. <https://circuitdigest.com>
2. [www. Github.com](http://www.Github.com)
3. <https://www.electronicshub.org>
4. <https://www.hackster.io/>

NPTEL Courses:

1. **Introduction to Embedded System Design (using MSP430)**
https://onlinecourses.nptel.ac.in/noc20_ee98/preview
2. **Embedded System Design with ARM**
https://onlinecourses.nptel.ac.in/noc20_cs15/preview
3. **Embedded systems**
<https://nptel.ac.in/courses/108/102/108102045/>
4. **Master Microcontroller and Embedded Driver Development(MCU1) STM32**
https://www.udemy.com/course/mastering-microcontroller-with-peripheral-driver-development/?gclid=CjwKCAjw07qDBhBxEiwA6pPbHsLLI-EqmAv7E17ysZETbreXe0XMb8Nai4NBqpUAvni5v-3fLKsfNB0C8LQQAyD_BwE&matchtype=b&utm_campaign=LongTail_la.EN_cc.INDIA&utm_content=deal4584&utm_medium=udemyads&utm_source=adwords&utm_term=.ag_82876601447_.ad_511749008336_.kw_%2Bembedded+%2Bsystems+%2Bcourse_.de_c_.dm_.pl_.ti_kwd-671751469914_.li_1007785_.pd_.
5. **Texas Instruments (TI) Trainings**
<https://e2e.ti.com/support/archive/universityprogram/educators/w/wiki/2103/training-support>
6. **Texas Instruments (TI) Teaching material/ text books**
<https://e2e.ti.com/support/archive/universityprogram/educators/w/wiki/2035/textbooks>

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC601	Electromagnetics and Antenna	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC601	Electromagnetics and Antenna	20	20	20	80	03	--	--	100

Pre-requisites:

1. Vector Calculus
2. Fundamental concepts of electricity and magnetism

Course Objective: The objective of the course is to make student familiar with Maxwell's equation and its usefulness to describe different electromagnetic phenomena such as wave propagation, radiations from antenna etc.

Course Outcome: Student will be able to:

1. Students will be able to describe electromagnetics field including static and dynamic in terms of Maxwell's equations.
2. Students will be able to apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave.
3. Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc.
4. Students will be able to implement different types of the antenna structures such as Antenna arrays, Microstrip antenna and reflector antenna etc.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Static fields	06
	1.1	Charge, Coulomb's law, Charge configurations, Electric field intensity, Electric flux density, Gauss's law and applications, Current density, and Continuity equation	
	1.2	Scalar Electric Potential, Potential gradient, Laplace's and Poisson's equations	
	1.3	Biot Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential	
2.0		Electromagnetic Field and Maxwell's Equations	09
	2.1	Faraday's Law, Displacement current density, Maxwell's equation for time varying field, Boundary conditions.	
	2.2	EM wave propagation through lossy, perfect dielectric and conducting medium.	
	2.3	Power in EM Wave: Poynting theorem and Poynting vector	
3.0		Basic of Antennas	08
	3.1	Basic concepts: Radiation mechanism, Near field and far field radiation, retarded potential	
	3.2	Antenna Parameters: Isotropic antenna, Radiation pattern, radiation intensity, Beamwidth, directivity, Gain, beam efficiency, bandwidth, polarization, Input impedance, Antenna efficiency, Radiation resistance, Loss resistance, aperture concept, FRIT's transmission formula	
	3.3	Wire Elements: Infinitesimal dipole, Wire dipole, Monopole antennas: radiation field derivations and related parameters, Introduction to loop antenna	
4.0		Antenna Arrays	06
	4.1	Linear arrays of two isotropic point sources, linear arrays of N elements, Principle of pattern multiplication	
	4.2	Introduction to Planar and circular arrays Introduction to array synthesis using Binomial array	
5.0		Types of antennas	06
	5.1	Yagi antenna, Broadband antenna like Helical and Log Periodic antenna Horn Antennas: E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn and Conical Horn	
	5.2	Reflector Antennas: Plane Reflectors, Corner Reflectors and Parabolic Reflector	
	5.3	Patch Antenna: Microstrip antenna, Feeding Techniques, Introduction to design of Microstrip antenna (Rectangular and circular patch)	
6.0		Electromagnetic Wave Propagation	04
	6.1	Ground Wave Propagation, Sky Wave Propagation and Space Wave Propagation	
		Total	39

Textbooks:

1. Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2nd edition
2. Principles of Electromagnetics Engineering- Matthew N. O.Sadiku , S.V.Kulkarni, Oxford university press, 6th edition
3. Antenna Theory: Analysis and Design, Costantine A. Balanis, John Wiley Publication, 4th edition
4. Antenna and wave Propagation, John D Kraus, A S Khan, McGraw Hill, 4th edition
5. Antenna Theory and Design. Stutzman, Theile, John Wiley and Sons, 3rd edition

Reference Books:

1. Engineering Electromagnetics, William H Hayt and John A Buck, Tata McGraw-Hill Publishing Company Limited, 7th edition
2. Antennas and Radio Wave Propagation, R. E. Collin, McGraw Hill, International Student Edition

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Subject Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC602	Computer Communication Networks	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC602	Computer Communication Networks	20	20	20	80	03	--	--	100

Course pre-requisite:

ECC: 405– Principles of communication engineering

ECC: 501-Digital communication

Course Objectives:

1. To introduce networking architecture and protocols.
2. To understand and recognize the layer-wise functions, services, data formats, protocols, hardware devices and addresses in the TCP/IP architecture
3. To build an understanding of application layer protocols.
4. To apply different addressing and routing schemes.

Course Outcomes:

After successful completion of the course student will be able to:

1. Analyze network topologies, hardware devices, addressing schemes and the protocol stacks
2. Compare various transmission media and broadband technologies
3. Analyze the flow control, error control and the medium access control techniques
4. Judge network layer addressing and routing schemes
5. Analyze connection oriented and connectionless services
6. Apply the knowledge of application layer protocols

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Network Architectures, Protocol Layers, and Service models	06
	1.1	Applications of computer networks. Network types: LAN, MAN, and WAN, Network topologies.	
	1.2	Protocols and standards, need of layered protocol architecture, OSI reference model.	
	1.3	TCP/IP architecture: protocol suite, comparison of OSI and TCP/IP	
	1.4	Layer wise network hardware devices (NIC, Repeaters, Hubs, Bridges, Switches, Routers, Gateway and their comparison)	
	1.5	Addressing: physical / logical /port addressing/socket addressing.	
2.0		Physical Layer	04
	2.1	Guided transmission media: comparison among coaxial, optical fiber and twisted pair cables.	
	2.2	Unguided transmission media	
	2.3	Transmission impairments	
	2.4	Broadband standards: Cable modem, DSL, and HFC	
3.0		Data Link Layer	07
	3.1	Data link services: Framing, Flow control, Error control	
	3.2	ARQ methods: transmission efficiency, Piggybacking	
	3.3	High Level Data Link Control (HDLC): HDLC configurations, Frame formats, HDLC bit stuffing and de-stuffing, Typical frame exchanges.	
	3.4	Medium Access Control Protocols: ALOHA, Slotted ALOHA, CSMA, CSMA/CD	
4.0		Network Layer	12
	4.1	Introduction to telephone networks and circuit switching principles.	
	4.2	Introduction to data networks and packet switching principles.	
	4.3	Network layer services and functions.	
	4.4	Internet Protocol: Principles of Internetworking, requirements, IPv4 packet, IPv4 addressing (classful and classless (CIDR))	
	4.5	Routing in Packet Switching Networks: Characteristics, Routing strategies	
	4.6	Routing algorithms: Link state Routing, Distance vector Routing and Path vector routing, Routing protocols: RIP, OSPF, BGP and EIGRP.	
	4.7	Subnetting, supernetting, VLSM, and NAT	
	4.8	Introduction to ICMP, ARP, RARP	
	4.9	IPv6 (IPv6 Datagram format, comparison with IPv4, and transition from IPv4 to IPv6).	
	4.10	Quality of service	
5.0		Transport Layer	06
	5.1	Connectionless and Connection-oriented services at transport layer, Transmission Control Protocol (TCP): TCP Services, TCP Segment, TCP three way handshake	
	5.2	User datagram Protocol (UDP), UDP Services, UDP Datagram	
	5.3	TCP and UDP checksum calculation	
	5.4	Flow control, error control and congestion control	

6.0		Application Layer	04
	6.1	Introduction to Application layer Protocols: HTTP, FTP, DNS, SMTP, TELNET, SSH, DHCP.	
Total			39

Text books:

1. Data Communications and Networking – Behrouz A. Forouzan, Fifth Edition TMH, 2013.
2. Computer Networks -- Andrew S Tanenbaum, 5th Edition, Pearson Education, 2013.
3. J J. F. Kurose and K. W. Ross,” Computer Networking: A Top-Down Approach”, Addison Wesley, 5th Edition, 2010

Reference books:

1. Alberto Leon Garcia, “Communication Networks”, McGraw Hill Education, Second Edition, Fourth Edition, 2008.
2. An Engineering Approach to Computer Networks-S.Keshav, 2nd Edition, Pearson Education, 2015.
3. Understanding communications and Networks, 3rd Edition, W.A.Shay, Cengage Learning
4. Data and Computer Communications, William Stallings, 10th Edition, Pearson Education, 2014.

Internal Assessment (IA):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Question No: 01 will be compulsory and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
- 4.Total 04 questions need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC603	Digital Image Processing and Machine Vision	03	--	--	03	--	-	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC603	Digital Image Processing and Machine Vision	20	20	20	80	03	--	--	100

Prerequisites:

1. Signals and Systems
2. Discrete Time Signal Processing
3. Python Programming Skill Lab

Course Objectives:

1. To teach the fundamentals and mathematical models in digital image processing and Machine Vision
2. To teach quality enhancement of image through filtering operations
3. To teach the students image morphology and restoration techniques
4. To expose the students to segmentation techniques in image processing and Machine Vision
5. To teach the techniques of extracting image attributes like regions and shapes
6. To learn classification and recognition algorithms for machine vision

Course Outcomes:

After successful completion of the course student will be able to

1. Understand fundamentals of image processing and machine vision
2. Enhance the quality of image using spatial and frequency domain techniques for image enhancement
3. Learn image morphology and restoration techniques
4. Learn image segmentation techniques based on principle of discontinuity and similarity using various algorithms
5. Represent boundaries and shapes using standard techniques.
6. Classify the object using different classification methods

Module No.	Unit No.	Topics	Hrs.
1	DIGITAL IMAGE FUNDAMENTALS AND POINT PROCESSING		04
	1.1	Introduction –Steps in Digital Image Processing, concept of spatial and intensity resolution, Relationships between pixels	02
	1.2	Point Processing : Image Negative, Log Transform, Power Law transform, Bit plane slicing, Contrast stretching , Histogram equalization and Histogram Specification	02
2	IMAGE ENHANCEMENT		08
	2.1	Spatial Domain filtering : The Mechanics of Spatial Filtering, Smoothing Spatial Filters -Linear Filters-Averaging filter, Order-Statistic Filters- Median filter, Application of Median filtering for Noise removal Sharpening Spatial Filters - The Laplacian, Unsharp Masking and Highboost Filtering, Using First-Order Derivatives —The Gradient- Sobel, Prewitt and Roberts	03
	2.2	Frequency Domain Filtering: Introduction to 2-D DFT and its application in frequency domain filtering, Wavelet transform, Haar transform	02
	2.3	Frequency Domain Filtering Fundamentals , Fourier Spectrum and Phase angle ,Steps for Filtering in the Frequency Domain, Correspondence Between Filtering in the Spatial and Frequency Domains, Frequency domain Image Smoothing and sharpening filter - Ideal, Butterworth , Gaussian	03
3	IMAGE MORPHOLOGY AND RESTORATION		06
	3.1	Morphology: Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Boundary extraction , Hole filling, Thinning and thickening	04
	3.2	Restoration : A Model of the Image Degradation/Restoration Process, Noise models, Removal periodic noise, Principle of Inverse filtering	02
4	IMAGE SEGMENTATION		08
	4.1	Point, Line, and Edge Detection: Detection of Isolated Points, Line detection, edge models, Canny's edge detection algorithm , Edge linking : Local processing and boundary detection using regional processing (polygonal fitting)	05
	4.2	Thresholding : Foundation, Role of illumination and reflectance, Basic global thresholding	01
	4.3	Region Based segmentation: Region Growing, Region Splitting and merging	02
5	INTRODUCTION TO MACHINE VISION AND DESCRIPTORS		05
	5.1	Principle of machine vision , real world applications, chain code, simple geometric border representation, Fourier Transform of boundaries, Boundary description using segment sequences	03
	5.2	Introduction to Texture, co-occurrence matrix	02
6	MACHINE VISION ALGORITHMS		08
	6.1	Knowledge representation, Classification Principles, Classifier setting, Classifier Learning, Confusion Matrix	02
	6.2	K-means clustering algorithm, Introduction, bays decision theory continuous case, two category classification, Bayesian classifier ,Support vector machine	06
TOTAL			39

Text Books:

1. Milan Sonka ,Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision” Cengage Engineering, 3rd Edition, 2013
2. Gonzales and Woods, “Digital Image Processing”, Pearson Education, India, Third Edition,
3. R. O. Duda and P. E. hart, Pattern classification and scene analysis, Wiley Interscience publication
4. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006

Reference books:

1. Anil K.Jain, “Fundamentals of Image Processing”, Prentice Hall of India, First Edition, 1989.
2. W Pratt, “Digital Image Processing”, Wiley Publication, 3rd Edition, 2002
3. Forsyth and Ponce, Computer vision: A modern approach, PHI
4. Frank Y Shish ,Image Processing and Pattern Recognition: Fundamentals and Techniques, Wiley Wiley-IEEE Press, 2010

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC604	Artificial Neural Networks and Fuzzy Logic	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECC604	Artificial Neural Networks and Fuzzy Logic	20	20	20	80	03	--	--	100

Course Prerequisites:

1. Basic linear Algebra
2. Engineering Mathematics-I to IV

Course Objectives:

1. To introduce the concepts and understanding of artificial neural networks
2. To provide adequate knowledge about supervised and unsupervised neural networks
3. To introduce neural network design concepts
4. To expose neural networks based methods to solve real world complex problems
5. To study the architecture of CNN and its application in image classification.
6. To introduce fuzzy logic and fuzzy inference systems

Course Outcomes:

After successful completion of the course, the student will be able to:

1. Comprehend the concepts of biological neurons and artificial neurons
2. Analyze the feed-forward and feedback neural networks and their learning algorithms.
3. Comprehend the neural network training and design concepts
4. Build a simple CNN model and apply in image classification
5. Analyze the application of neural networks and fuzzy logic to real world problems.

Module No.	Topics	Hrs.
1.0	Introduction to Neural Networks and their Basic Concepts	07
	Biological neuron and Artificial neuron, McCulloch-Pitts Model, Activation Function, various types of Activation Functions and types of Neural Network Architectures, Prerequisites for Training of Neural Networks. Linearly Separable and Linearly Non-Separable Systems with examples, Concepts of Supervised Learning, Unsupervised Learning, and Reinforcement Learning. Brief survey of applications of Neural Networks.	
2.0	Supervised Learning Neural Networks	07
	Perceptron - Single Layer Perceptron, Multilayer Perceptron and their Architecture. Error Functions: Mean Square Error and Sum Squared Error. Gradient Descent, Generalized delta rule, Error back propagation, Stopping Criteria for Training.	
3.0	Unsupervised Learning Neural Networks	07
	Competitive Learning Network – Kohonen Self-Organizing Networks – Architecture, Training Algorithm, Discrete Hopfield Network- Hopfield Matrix, Testing Algorithm, K-Means Clustering Algorithm.	
4.0	Algorithms of Neural Networks	04
	Basic concept of Machine Learning, Support Vector Machine (SVM) - Introduction and SVM based Binary Classifier, LMS Algorithm.	
5.0	Convolution Neural Network (CNN)	07
	Basic concept of Deep Learning, Convolution Operation, Overview of CNN Architecture, Input layer, Convolution layers, Pooling layers, Padding, Strided Convolutions, Rectified Linear Unit (ReLU), One Layer of a Convolutional Network, Fully Connected Layers, Complex Image Classification using CNN.	
6.0	Introduction to Fuzzy Inference System	07
	Introduction to Fuzzy Logic, Fuzzy Rules, Fuzzy Properties - Operations, Membership Functions, Fuzzification - Membership Value Assignments using Intuition Method, Defuzzification Methods -- Mean of Maxima and Centroid (Centre of Area) Methods, Fuzzy Inference System with reference to Mamdani Model, Brief Review of Applications of Fuzzy Logic to Speed Control of DC Motor and Washing Machine.	
	Total	39

Text Books:

1. S. N. Sivanandam and S. N. Deepa, Introduction to Soft Computing, Wiley India Publications, 3rd Edition.
2. Simon Haykin, Neural Networks and Learning Machines, Pearson Prentice Hall, 3rd Edition
3. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms, PHI Learning Pvt. Ltd, 2003.
4. Practical Convolutional Neural Networks by Mohit Sewak, Md. Rezaul Karim, Pradeep Pujari, Packt Publishing, 2018.
5. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley India Publications, 3rd Edition.

References:

1. Hagan, Demuth, and Beale, Neural Network Design, Thomson Learning, 2nd Edition.
2. Simon Haykin, Neural Network- A Comprehensive Foundation, Pearson Education, 2nd Edition.
3. Christopher M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 2005.
4. William W. Hsieh, Machine Learning Methods in the Environmental Sciences: Neural Network and Kernels, Cambridge University Press, 2009.
5. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016
6. S. N. Sivanandam, S. Sumathi, and S. N. Deepa, Introduction to Neural Network using Matlab, Tata McGraw-Hill Publications, 2006.
7. Mehrotra Kishan, Mohan C. K. Ranka Sanjay, Elements of Artificial Neural Networks, Penram International Publishing Pvt. Ltd, 2nd Edition.
8. J. M. Zurada, Introduction to Artificial Neural Systems, Jaico Publishers, 2006.
9. Bart Kosko, Neural Networks and Fuzzy Systems, Pearson Education, 2007.

Recommended NPTEL / Swayam Course and Online resources:

1. Course: Fuzzy Logic and Neural Networks by Prof. Dilip Kumar Pratihar, IIT Kharagpur
2. Course: Neural Network and Applications by Prof. Somnath Sengupta, IIT Kharagpur
3. Michael Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015.
<http://neuralnetworksanddeeplearning.com/>

List of Suggested Experiments to be conducted in IPMV Laboratory (ECL 603):

1. **Classification of Non-linearly Separable Binary Pattern using Multilayer Perceptron Neural Network.**
2. **Pattern Clustering using K-means Algorithm.**
3. **Binary Pattern Restoration using Discrete Hopfield Neural Network.**
4. **Image Classification using Support Vector Machine.**
5. **Object Recognition using Convolutional Neural Network.**
6. **Design Fuzzy Controller for Washing Machine**

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed, and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on the entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6011	Mixed Signal VLSI	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 6011	Mixed Signal Design	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC302 – Electronic Devices and Circuits
ECC303 –Digital System Design
ECC403 – Linear Integrated Circuits
ECC503 – Digital VLSI

Course Objectives:

1. To know importance of Mixed Signal VLSI design in the field of Electronics and Telecommunication and emerging technologies.
2. To understand various methodologies for analysis and design of fundamental CMOS analog and mixed signal Circuits.
3. To learn various issues associated with high performance Mixed Signal VLSI Circuits
4. To design, implement and verify various mixed signal VLSI circuits using open source tools like Ngspice and Magic.

Course Outcomes:

After successful completion of the course student will be able to:

1. Know operation of the various building blocks of analog and mixed signal VLSI circuits.
2. Demonstrate the understanding of various building blocks and their use in design of analog and mixed signal circuits.
3. Derive expression for various performance measures of analog and mixed signal circuits in terms of parameters of various building blocks used to build the circuit.
4. Analyze and relate performance of analog and mixed signal VLSI circuits in terms of design parameters.
5. Evaluate and select appropriate circuit/configuration for given application.
6. Design analog and mixed signal VLSI circuits for given application.

Module No.	Unit No.	Topics	Hrs.
1.0		Integrated Circuit Biasing Techniques	06
	1.1	Active resistance, current source, current sink, simple current mirror, cascode current mirror	03
	1.2	Current and voltage references, Band gap reference generator	03
2.0		Single Stage MOS Amplifiers	08
	2.1	Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascode stage, simulation of CMOS amplifiers using SPICE	04
	2.2	Single-ended operation, differential operation, basic differential pair, large-signal and small-signal behavior, common-mode response, differential pair with MOS loads, simulation of differential amplifiers using SPICE	04
3.0		Noise in MOS Circuits	06
	3.1	Noise spectrum, correlated and uncorrelated noise sources, thermal noise, flicker noise, shot noise	02
	3.2	Representation of noise in circuits, noise in single stage CS, CD and CG amplifier	02
	3.3	Noise in differential pairs, noise bandwidth	02
4.0		CMOS Operational Amplifier	05
	4.1	Design of Current Mirror Load Differential Amplifier	02
	4.2	Design of two stage Operational Transconductance Amplifier, OpAmp Compensation techniques	03
5.0		Data Converter Fundamentals	06
	5.1	Analog versus digital discrete time signals, converting analog signals to data signals, sample and hold characteristics	03
	5.2	Mixed signal Layout issues, Floor planning, power supply and Ground issues, other interconnect Considerations	03
6.0		Data Converter Architectures	08
	6.1	DAC architectures, digital input code, charge scaling DACs, Cyclic DAC, pipeline DAC	04
	6.2	ADC architectures, flash, pipeline ADC, integrating ADC, and successive approximation ADC	04
		Total	39

Text Books:

1. B. Razavi, “*Design of Analog CMOS Integrated Circuits*”, first edition, McGraw Hill, 2001.
2. P.E. Allen and D R Holberg, “*CMOS Analog Circuit Design*”, second edition, Oxford University Press, 2002.
3. R. Jacob Baker, “*CMOS Circuit Design, Layout and Simulation*”, Wiley, 2nd Edition, 2013

Reference Books:

1. Adel S. Sedra, Kenneth C. Smith, A.N. Chandorkar, “*Microelectronics Circuits Theory and Applications*”, Fifth Edition, Oxford University Press.
2. Gray, Meyer, Lewis and Hurst “*Analysis and design of Analog Integrated Circuits*”, 4th Edition Wiley International, 2002
3. Tony Chan Carusone, David Johns, Kenneth Martin, “*Analog Circuit Design*”, Second Edition, Wiley

NPTEL / Swayam Course:

1. <https://nptel.ac.in/courses/117/101/117101105/>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on completion of approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6012	Computer Organisation and Architecture	3	--	--	3	--	--	3

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECCDLO 6012	Computer Organisation and Architecture	20	20	20	80	03	--	--	100

Course Pre-requisites:

ECC303-Digital System Design

ECC402-Microcontrollers

Course objectives:

1. To have a thorough understanding of the basic structure and operation of a digital computer.
2. To understand memory systems, processor organization and generation of control unit signals.
3. To demonstrate the operation of various arithmetic algorithm including integer and floating point representation.
4. To understand the working principles of multiprocessor and parallel organization's as advanced computer architectures.

Course outcomes:

After successful completion of the course student will be able to -

1. Describe Computer system along with I/O operations and performance measures.
2. Demonstrate data representation and different arithmetic algorithm for solving ALU operations.
3. Categorize memory organization and identify the function of each element of memory hierarchy.
4. Demonstrate control unit operations.
5. Articulate design issues in the development of Multiprocessor organization & architecture

Module No.	Unit No.	Topics	Hrs
1		Computer Organization, Architecture and Performance	8
	1.1	Organization and Architecture,	
	1.2	Structure and Function,	
	1.3	Designing for Performance,	
	1.4	Multicore, MICs, and GPGPUs	
	1.5	Two Laws that Provide Insight: Amdahl's Law and Little's Law	
	1.6	Basic Measures of Computer Performance,	
	1.7	Calculating the Mean	
	1.8	Benchmarks and SPEC	
2		Computer System	6
	2.1	Computer Components	
	2.2	Computer Function	
	2.3	Interconnection Structures	
	2.4	Bus Interconnection	
3		Data Representation and Arithmetic Algorithms	5
	3.1	Unsigned & Signed multiplication- Add & Shift Method, Booth's algorithm. Unsigned & Signed division, Restoring and non-restoring division.	
	3.2	Integer and floating point representation, IEEE 754 standard for floating point (Single & double precision) number representation.	
4		Memory System Organization	7
	4.1	Classification and design parameters, Memory Hierarchy ,Internal Memory: RAM, SRAM and DRAM	
	4.2	Cache Memory: Characteristics of Memory Systems, Cache Memory Principles, Elements of Cache, Cache Coherence. Design problems based on mapping techniques	
	4.3	Virtual Memory, External Memory : Magnetic Discs, Solid State Drive, Optical Memory, Flash Memories, RAID Levels	
5		Control Unit Design	8
	5.1	Micro- Operations: The Fetch Cycle, The Indirect Cycle, The Interrupt Cycle, The Execute cycle, The Instruction Cycle	
	5.2	Control of the Processor: Functional Requirements, Control Signals, Internal Processor Organization	
	5.3	Hardwired Control Unit	
	5.4	Microinstructions Microprogrammed Control Unit, Advantages & disadvantages	
6		Fundamentals of Advanced Computer Architecture	5
	6.1	Parallel Architecture: Classification of Parallel Systems,	
	6.2	Flynn's Taxonomy, Array Processors, Clusters, and NUMA Computers	
	6.3	Multiprocessor Systems : Structure & Interconnection Networks	
	6.4	Multi-Core Computers: Introduction, Organization and Performance.	
Total			39

Text Books:

1. William Stallings “Computer Organization and Architecture Designing for Performance” Tenth Edition, Pearson Education.
2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGrawHill,
3. Andrew S. Tanenbaum “Structured Computer Organization”, Pearson, Sixth Edition

Reference books:

1. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design -
2. Morris Mano. “Computer System Architecture” Pearson Publication, 3rd Edition, 2007
3. J .P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998
4. B. Govindarajulu, “Computer Architecture and Organization: Design Principles and Applications”, Second Edition, Tata McGraw-Hill.

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal assessment. Duration of each test shall be of one hour.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6013	Digital Forensic	3	--	--	3	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 6013	Digital Forensic	20	20	20	80	03	--	--	100

Course prerequisite:

ECC602: Computer Communication Networks

Course Objectives:

1. To understand cyber attacks and various categories of Cybercrime.
2. To discuss the need and process of digital forensics and Incident Response Methodology.
3. To explore the procedures for identification, preservation, and extraction of digital evidence.
4. To explore techniques and tools used in digital forensics for system investigation.
5. To discuss the investigation process of network and host based system intrusions.
6. To understand the laws related to Cybercrime

Course Outcomes:

On successful completion of the course, students will be able to

1. Study the various cybercrimes and its prevention methods.
2. Discuss the phases of Digital Forensics and methodology to handle the computer security incident.
3. Understand the process of collection, analysis and recovery of the digital evidence.
4. Explore various tools to perform the investigation of the crime scenario.
5. Investigate the process of monitoring and analysis of computer network traffic for network investigation.
6. Discuss the legal issues associated with the cyber laws.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Cybercrime and Hacking	08
	1.1	Cybercrime, Categories of Cybercrime (Cybercrime against people, Cybercrime Against property, Cybercrime Against Government), Types of cybercrime (Violent- Cyber terrorism, Assault by Threat, Cyberstalking, Child Pornography, Non-violent - Cybertrespass, Cyber Theft, Cyberfraud, Destructive Cybercrimes), Computers' role in crimes	
	1.2	Hacking, Life cycle of Hacking, Types of Hackers (White Hat hackers, Black Hat hackers, Grey Hat hackers), Hacking techniques, Passive and Active Attacks, Social Engineering, Attacks vs Vulnerabilities, Prevention of Cybercrime	
		Self-learning topics: Distinction between computer crimes and conventional crimes.	
2.0		Introduction to Digital Forensics	07
	2.1	Objectives of digital forensics, Process of digital forensics, Types of digital forensics, Challenges faced by digital forensics	
	2.2	Introduction to Incident - Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phase after detection of an incident	
		Self-learning topics: Distinction between Computer virus, worm, Trojan horse and trap door.	
3.0		Digital Evidence and Forensics Duplication	07
	3.1	Digital evidence, Admissibility of evidence, Challenges in evidence handling, collecting digital evidence, Preserving digital evidence, Documenting evidence	
	3.2	Necessity of forensic duplication, Forensic duplicates as admissible evidence, Forensic image formats, Forensic duplication techniques, Disk imaging, Analysis of forensic images using FTK Imager	
		Self-learning topics: Digital Evidence Investigation using Autopsy	
4.0		System Investigation	08
	4.1	Live/volatile data collection from Windows and Unix Systems	
	4.2	Investigating Windows systems, Investigating UNIX systems, Investigating applications, Web browsers, Email tracing	
	4.3	Recovering digital evidence, Acquiring, Analyzing and duplicating data: dd, dcfldd, foremost, scalpel	
		Self-learning topics: Methods of storing data (RAM and Hard disk)	
5.0		Network Forensics	05
	5.1	Introduction to intrusion detection systems, Types of IDS, Understanding network intrusion and attacks	
	5.2	Analyzing network traffic, collecting network based evidence, Evidence handling. Investigating routers	
		Self-learning topics: Use of packet sniffing tools like Wireshark	
6.0		Laws related to cyber crime	04
		Constitutional law, Criminal law, Civil law, Levels of law: Local laws, State laws, Federal laws, International laws. Levels of culpability: Intent, Knowledge, Recklessness, Negligence. CFAA, DMCA, CAN Spam	
		Self-learning topics: Relevant law to combat computer crime –Information Technology Act	
		Total	39

Text books

1. Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGrawHill, 2006
2. "Scene of the Cybercrime: Computer Forensics" Handbook 1st Edition, Kindle Edition
3. "Digital Forensics", Nilakshi Jain & Kalbande, Wiley Publication
4. "Cyber Security", Nina Godbole, Sunit Belapure, Wiley Publication

Reference books

1. Bill Nelson, Amelia Phillips, Christopher Steuart, "Guide to Computer Forensics and Investigations" . Cengage Learning, 2014
2. Debra Littlejohn Shinder Michael Cross "Scene of the Cybercrime: Computer Forensics Handbook", 2nd Edition Syngress Publishing, Inc. 2008.
3. Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.

Suggested MOOCs for Self-Learning:

1. Course on "Ethical Hacking"
<https://nptel.ac.in/courses/106/105/106105217/>
2. Course on "Digital Forensics"
https://onlinecourses.swayam2.ac.in/cec20_1b06/preview
3. Course on "Computer Forensics"
<https://www.edx.org/course/computer-forensics>
4. Course on Cyber Incident Response
<https://www.coursera.org/learn/incident-response>
5. Course on "Penetration Testing, Incident Responses and Forensics"
<https://www.coursera.org/learn/ibm-penetration-testing-incident-response-forensics>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6014	Database Management System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 6014	Database Management System	20	20	20	80	03	--	--	100

Course Pre-requisite:

FEC 205 : C Programming
ECL 304 : Skill Lab :- C++ and Java Programming
ECL 405 : Skill Lab :- Python Programming

Course Objectives:

1. Learn and practice data modeling using the entity-relationship and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access
4. Understand the concept of database security and privacy

Course Outcome:

After successful completion of the course student will be able to

1. Describe the fundamentals of database systems, different data models and design issues in database.
2. Understand the basics model of relational Algebra, calculus, transaction management, concurrency control, database security and privacy
3. Design ER diagram, relational schemas, apply concepts of normalization to relational database design.
4. Implement views, triggers and querying the database using SQL.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Databases	02
	1.1	Introduction to databases, History of database system, Benefits of Database system over traditional file system, relational databases, Three tier database architecture, Data independence	
2.0		Data Models	03
	2.1	The importance of data models, Introduction to various data models (hierarchical, Network, Relational, Entity relationship and object model), Basic building blocks, Business rules, Degrees of data abstraction	
3.0		Database Design, ER-Diagram and Unified Modeling Language	08
	3.1	Database design and ER Model: overview, ER-Model and its Constraints, ER-Diagrams, ERD Issues, weak entity sets	
	3.2	Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, integrity rules. Relational Database design: features of good relational database design, atomic domain	
4.0		Relational Algebra and Calculus	09
	4.1	Relational algebra: Introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics.	
	4.2	Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities.	
	4.3	Normalization methods : 1NF, 2NF, 3NF, BCNF, 4NF, 5NF	
5.0		Constraints, Views and SQL	10
	5.1	What is constraints, types of constraints, Integrity constraints,	
	5.2	SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers.	
	5.3	Views: Introduction to views, data independence, security, updates on views, comparison between tables and views	
	5.4	** SQL Tools : MySQL, ORACLE 10G, POSTGRESQL	
6.0		Transaction management and Concurrency control	07
	6.1	Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management.	
	6.2	Database Security and privacy : Issues, Access Control based on grant and revoke privileges	
Total			39

**** Teacher can select any one SQL Tool for implementation of SQL query**

Textbooks:

1. A Silberschatz, H Korth, S Sudarshan, “Database System and Concepts”, Fifth Edition McGraw-Hill
2. Rob, Coronel, “Database Systems”, Seventh Edition, Cengage Learning.
3. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database System”, Seventh Edition, Person.
4. G. K. Gupta, “Database Management Systems”, McGraw – Hill.

Reference Books:

1. Peter Rob and Carlos Coronel, “Database Systems Design, Implementation and Management”, Thomson Learning, 5th Edition.
2. P.S. Deshpande, “SQL and PL/SQL for Oracle 11g, Black Book”, Dreamtech Press
3. Mark L. Gillenson, Paulraj Ponniah, “Introduction to Database Management”, Wiley
4. Raghu Ramkrishnan and Johannes Gehrke, “Database Management Systems”, TMH
5. Debabrata Sahoo “Database Management Systems” Tata McGraw Hill, Schaum’s Outline

E-Resources:

1. <https://www.w3schools.in/dbms/>
2. <https://www.tutorialspoint.com/dbms/index.htm>
3. <https://www.studytonight.com/dbms/>

Self-Learning: Suggested Case Studies (Any such cases can be selected by Teacher)

1. Library Management System
2. Hospital Management System
3. Pharmacy Management System
4. Human Resource Database Management System in Java
5. Students Database Management System
6. Employee Management System
7. Inventory Control Management database

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6015	IoT and Industry 4.0	3	-	--	3	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work Oral	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 6015	IoT and Industry 4.0	20	20	20	80	03	--	--	100

Course pre-requisite:

ECM401: Mini Project – 1 B

ECC402: Microcontrollers

ECL404: Skill based Lab Course

ECM501: Mini Project 2A Embedded System Project

Course Objectives:

1. To offer introduction to Internet of Things and industry 4.0 standard
2. To understand the design features of Internet of Things (IoT)
3. To understand concepts of data management and data analytics in IoT
4. To understand the concept and framework of industry 4.0 standard
5. To understand the application of IoT and Industry 4.0 standard.

Course Outcome:

On successful completion of the course the students will be able to:

1. Discuss case studies and use cases of IoT design.
2. Illustrate various protocols of web connectivity.
3. Understand and use tools for data management and analytics in IoT.
4. Explain various frameworks for industry 4.0 standards.
5. Prepare case studies on applications of IIOT.
6. Understand advanced concepts and applications of industry 4.0

Module No.	Unit No.	Topics	Hrs.
1		Introduction to IoT	04
	1.1	Introduction - Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT, IoT and M2M - IoT/M2M System layers and Design standardization, Difference between IoT and M2M	
	1.2	Defining Specifications About - Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration, Application Development, Case Study	
2		Network & Communication aspects	08
	2.1	Design Principles & Web Connectivity - Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and Web Sockets (Publish—Subscribe), MQTT, AMQP, CoAP Protocols	
	2.2	Internet Connectivity: - Internet connectivity, Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN Fundamentals: LORA, NBIoT, CAT LTE ML, SIGFOX, Case Study	
3		Data Management and Analytics for IoT	08
	3.1	Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Oozie, Apache Spark, ApacheStorm, Using Apache Storm for Real-time Data Analysis	
	3.2	Analysis, Structural Health Monitoring Case Study, Tools for IoT:- Chef, Chef Case Studies, Puppet, Puppet Case Study- Multi-tier Deployment, NETCONF-YANG Case Studies, IoT Code Generator	
4.0		Introduction to Industry 4.0	08
	4.1	Industry 4.0: Managing the Digital Transformation, Conceptual framework for Industry 4.0, Industrial IoT (IIoT) - Introduction, Business Model and Reference Architecture, Industrial IoT-Layers, Sensing, Processing, Communication.	
	4.2	Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality	
5.0		Introduction to Industrial IoT (IIoT)	06
	5.1	Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security, Facility Management.	
	5.2	Artificial Intelligence, Cybersecurity in Industry 4.0, Internet of Things for Industry 4.0 Design, Challenges and Solutions	
6.0		Industry 4.0 Technologies and Applications	05
	6.1	Internet of Things and New Value Proposition.: Examples for IoTs Value Creation in Different Industries., IoTs Value Creation Barriers: Standards, Security and Privacy Concerns	
	6.2	Introduction to Industry 5.0, Human Machine Interaction, cognitive computing with human intelligence, Case study on AI based solutions	
Total			39

Text books:

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press.
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw Hill Education, First edition
3. Radha Shankarmani, M Vijayalakshmi, "Big Data Analytics", Wiley Publications,
4. Andrew Minter, "Analytics for the Internet of Things (IoT)", Kindle Edition
5. Giacomo Veneri, Antonio Capasso, "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Packt

Suggested reference material (research papers):

1. <https://www.mdpi.com/2071-1050/11/16/4371/pdf>- Industry 5.0—A Human-Centric Solution – MDPI (open access)
2. https://www.researchgate.net/profile/Mary-Doyle-Kent/publication/336819748_Industry_50_Is_the_Manufacturing_Industry_on_the_Cusp_of_a_New_Revolution/links/5e84b810a6fdcca789e5ff75/Industry-50-Is-the-Manufacturing-Industry-on-the-Cusp-of-a-New-Revolution.pdf - Industry 5.0: Is the Manufacturing Industry on the Cusp of a New Revolution?

Reference books

1. Alp Ustundag Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing
2. G. R. Kanagachidambaresan, R. Anand, E. Balasubramanian, V. Mahima, Internet of Things for Industry 4.0. EAI/Springer Innovations in Communication and Computing
3. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications).
4. The Internet of Things (MIT Press) by Samuel Greengard
5. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback, First Edition

Suggested MOOCs:

1. https://onlinecourses.nptel.ac.in/noc20_cs69 - Introduction to Industry 4.0 and Industrial Internet of Things, By Prof. Sudip Misra, IIT Kharagpur
2. <https://www.edx.org/course/industry-40-how-to-revolutionize-your-business> - Industry 4.0: How to Revolutionize your Business
3. https://onlinecourses.nptel.ac.in/noc21_cs17 - Introduction to internet of things, by Prof. Sudip Misra, IIT Kharagpur
4. https://onlinecourses.nptel.ac.in/noc21_cs08 - Embedded Systems Design
5. By Prof. Anupam Basu, IIT Kharagpur

Recommended list of tools for self learning:

1. Node Red - <https://nodered.org/>
2. M2MLabs Mainspring - <http://www.m2mlabs.com/>
3. Tensor Flow - <https://www.tensorflow.org/>
4. Things Speak - <https://thingspeak.com/>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 6016	Radar Engineering	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 6016	Radar Engineering	20	20	20	80	03	--	--	100

Pre requisites:

ECC405 - Principles of Communication Engineering

Course objectives:

1. To interpret Radar equations
2. To explain different types of radar
3. To introduce RADAR transmitters and receivers for given conditions
4. To understand/ implement the plotting for given RADAR target

Course outcomes:

After successful completion of the course student will be able to

1. Explain generalized concept of RADAR.
2. Solve problems using radar equations.
3. Describe different types of radar for specific application.
4. Explain concept of tracking radar.
5. Plot the RADAR target from given specification.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Radar and Radar Equation	08
	1.1	Basics Radar, Radar equation, Block Diagram, Radar Frequencies	
	1.2	Detection of signal in noise, Receiver Noise and Signal-to-noise Ratio	
	1.3	Probability of detection and false alarm: Simple, complex Targets, Pulse Repetition Fr	
2.0		MTI and Pulse Doppler Radar	08
	2.1	Introduction to Doppler and MTI radar, Doppler frequency shift	
	2.2	Simple CW Doppler radar, MTI radar block diagram	
	2.3	Delay line canceler	
	2.4	Moving-target-detection	
	2.5	Pulse Doppler radar	
3.0		Tracking Radar	06
	3.1	Monopulse tracking	
	3.2	Conical scan and sequential lobbing	
	3.3	Limitation of tracking accuracy , Low angle tracking	
4.0		Radar Transmitters and Receivers	06
	4.1	Radar RF power sources: Klystron	
	4.2	Travelling wave tube	
	4.3	Magnetron	
	4.4	Radar Receiver: Superheterodyne Receiver	
5.0		Radar Clutters and landing system	06
	5.1	Types of clutter : surface clutter, sea clutter, land clutter	
	5.2	Instrument landing system	
	5.3	Ground controlled approach, Microwave landing system	
	5.4	Radar altimeter	
6.0		General ideas on RADAR plotting	05
	6.1	Radar plotting -general ideas	
	6.2	Relative plotting (passive derivations), Relative plotting (action taken by target)	
	6.3	Radar Display: Types of displays	
Total			39

Text Books:

1. Merill Skolnik,—Introduction to RADAR Systems,Tata McGrawHill, Third Edition
2. Merill Skolnik,—RadarHandbook, TataMcgrawHill, Second Edition
3. Dr. A. K. Sen, Dr. A. B. Bhattacharya- Radar Systems and Radio Aids to Navigation
Khanna Publishers

Reference books:

1. Mark A.Richards,James A.Scheer, William A.Holm, —Principles of Modern Radar
Basic Principalsl, ScitechPublishing.
2. SimonKingsley,ShaunQuegon,—UnderstandingRadarSystemsl,ScientechPublishing
Inc.
3. G.S. N.Raju, —Radar Engineering and Fundamentals of Navigational Aidsl, I. K
International publishing House Pvt.Ltd.
4. Dr. Arjun Singh -Radar Systems and Radio Aids to Navigation,McGraw-Hill Education
Private Limited
5. CAPT. H. SUBRAMANIAM- Shipborne Radar And Arpa Nutshell Series Book3

Online Resource:

1. NPTEL online Course: <https://nptel.ac.in/courses/108/105/108105154/>

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus completed and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ECL601	Electromagnetics and Antenna Lab	--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. of Test 1 and Test 2				
ECL601	Electromagnetics and Antenna Lab	--	--	--	--	25	25	50

Prerequisites:

1. Vector Calculus
2. Fundamental concepts of electricity and magnetism

Course Objective:

The objective of the course is to make student familiar with Maxwell's equation and its usefulness to describe different electromagnetic phenomena such as wave propagation, radiations from antenna etc.

Course Outcomes:

After successful completion of the course student will be able to

1. Students will be able to describe electromagnetics field including static and dynamic in terms of Maxwell's equations.
2. Students will be able to apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave.
3. Students will derive the field equations for the basic radiating elements and describe basic antenna parameters like radiation pattern, directivity, gain etc.
4. Students will be able to implement different types of the antenna structures such as Antenna arrays, Microstrip antenna and reflector antenna etc.

SUGGESTED LIST OF EXPERIMENTS

Sr. No.	NAME OF EXPERIMENTS
1.	Study different Antenna parameters (compulsory to use: FSM, Spectrum Analyzer and VNA)
2.	Introduction to Different Antenna Types
3.	Study of Wire Antenna, (Radiation pattern of dipole, folded dipole and Monopole antenna, various loops)
4.	Study of Directive antenna, Yagi-Uda Antenna
5.	Study of Broad-band Antenna, Log-periodic Antenna
6.	Study of Antenna Arrays (Broadside, End-fire, Parametric study for various arrays parameters)
7.	Study of Aperture Antennas (Parabolic/ Hyperbolic/ Horn , with or without Reflector)
8.	Study of Regular shaped Microstrip Antenna
9.	Small Project report can be considered as a part of term-work (Design, Simulation and validation).
10.	Case Study of Recent reported variations of Antenna types (Paper from reputed journal is to be referred and thoroughly study and present the report, maximum four students per group)

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the — Laboratory session batch wise”.

Computation/ simulation-based experiments are also encouraged. The experiments should be students centric, and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini project can be conducted for maximum batch of four students.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL602	Computer Communication Network Laboratory	-	02	-	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECL602	Computer Communication Network Laboratory	--	--	--	--	25	25	50

Lab Course Outcomes: -

Upon completion of the computer communication networks lab, the students will be able to:

- Design a small or medium sized computer network including media types, end devices, and interconnecting devices that meets a customer's specific needs.
- Perform configurations on routers and Ethernet switches.
- Demonstrate knowledge of programming for network communications.
- Simulate computer networks and analyze the simulation results.
- Troubleshoot connectivity problems in a host occurring at multiple layers of the OSI model.
- Develop knowledge and skills necessary to gain employment as computer network engineer and network administrator.

Laboratory plan

Minimum of 8 practicals should be conducted and a mini project.

Suggested list of experiments:

1. To study basic networking commands. (Linux/Netkit)
2. To prepare a patch cable (straight-through, crossover, rollover) using UTP, RJ-45 and crimping tool. Test the cable using a cable tester and use it in LAN.
3. To configure and compare different network topologies using Cisco Packet Tracer
4. To study and compare network hardware components using Cisco Packet Tracer
5. To configure static routes in a network using Cisco Packet Tracer.
6. To configure a network with Distance Vector Routing Protocol-RIP using Cisco Packet Tracer and check the updated routing tables.
7. To configure a network with Path Vector Routing Protocol- BGP using Cisco Packet Tracer and check the updated routing tables.

8. To configure a network with Link state Routing Protocol- OSPF using Cisco Packet Tracer and check the updated routing tables.
9. To configure a network with Hybrid Routing Protocol- EIGRP using Cisco Packet Tracer and check the updated routing tables.
10. To perform subnetting using Cisco Packet Tracer/Netkit
11. To install a network simulator (NS2.35), create a wired network and compare the performance of TCP and UDP **or** Compare TCP and UDP performance using Netsim
12. To Simulate and study stop and Wait protocol using NS 2.35/ C++
13. To Simulate Sliding Window protocol using NS 2.35/C++
14. To Simulate and study the implementation of TCP/IP stack using wireshark (observe the protocols, data formats, header structures, addresses, payload sizes and encapsulation at each layer)
15. To perform HDLC bit stuffing and de-stuffing using C++
16. To configure DNS, DHCP, TELNET, FTP, SMTP server (any one) on Cisco Packet Tracer
17. To compare performance of ALOHA and Slotted ALOHA using Netsim.

Term Work: At **least 08 Experiments** covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented **one mini-project** can be conducted for a batch of maximum four students.

Term work assessment must be based on the overall performance of the student with every experiment and assignment graded from time to time. The grades will be converted to marks as per “**Credit and Grading System**” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. The practical and oral examination will be based on entire syllabus.

Termwork marks distribution: Journal and practical Performance: 15 marks

Attendance: 5 marks

Assignment: 5 marks

Course Code	Course Name	Teaching Scheme			Credits Assigned			
ECL603	Image Processing and Machine Vision Laboratory	Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
		--	02	--	--	1	--	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg.				
ECL603	Image Processing and Machine Vision Laboratory	--	--	--	--	25	25	50

Prerequisites:

1. Python Programming Skill Lab

Course Objectives:

1. To teach implementing basic theoretical concepts in Image Processing and Machine Vision using relevant software.
2. To give an exposure to students to object recognition/ classification techniques in Machine Vision.
3. To facilitate students for understanding practical aspects of Image Processing and Machine Vision through an application.

Course Outcomes:

After successful completion of the course student will be able to

1. perform enhancement of digital images in spatial and frequency domain
2. perform edge detection and morphological operations on digital images
3. classify patterns using standard Machine vision classification techniques like SVM
4. apply theoretical knowledge in image processing and machine vision to practical case studies

SUGGESTED LIST OF EXPERIMENTS

1. Eight experiments covering the whole syllabus with proportional weightage to Image Processing and Machine Vision, to be set with predefined and concrete objective problem statement.
2. At least 5 programs to be conducted in python programming
3. At least 1 case study from suggested ones to be conducted in lab.
4. An attempt should be made to make experiments more meaningful, interesting and innovative.
5. Conduct three experiment based on application of **Neural Network and Fuzzy logic** for Image Processing.

Sr. No.	NAME OF EXPERIMENTS
1.	Point Processing Methods - Negative, Log, Power law, Contrast stretching, Bit plane slicing
2.	Histogram calculation and equalization
3.	Spatial Domain Filtering: 1. Smoothing filters 2. Sharpening with Laplacian 3. Unsharp masking & high boost filtering 4. Edge detection using 1st and 2nd order derivatives
4.	Frequency Domain Filtering : Ideal, Butterworth and Gaussian
5.	Morphological operation – Erosion, dilation, opening, closing, hit-miss transform, Boundary extraction
6.	Image segmentation using global Thresholding Algorithm
7.	Shape representation using chain code
8.	Canny edge detection
9.	Feature extraction using co-occurrence matrix
10.	Classification using k-means algorithm
11.	Classification using Basiyan classifier
12.	Basic binary classification of any data or pattern using Support Vector Machine.
13.	Case Study : 1. Face recognition 2. Finger print identification 3. License plate recognition

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL604	Skill Laboratory: Linux & Networking & Server Configuration	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECL604	Skill Laboratory: Linux & Networking & Server Configuration	--	--	--	--	25	25	50

Course pre-requisite:

FEL204__C-Programming

Course Objectives:

1. Install Linux and implement standard Linux commands
2. Study basic theory of Linux Operating System
3. Implement the system administrative functionality
4. To write shell script programs to solve problems
5. Study basic commands of networking
6. Develop implementation skill of different servers on Linux

Course Outcome:

After successful completion of the course student will be able to :-

1. Install Linux using different platform and execute standard Linux commands.
2. Describe the basic knowledge of Linux Operating System
3. Deploy the system administrative functionality
4. Solve the problems using shell script programming
5. Develop network based applications
6. Apply the Linux commands using programming skill to deploy different servers like ftp, telnet etc.

Module No.	Unit No.	Topics	Hrs.
1.0		Overview of Linux	08
	1.1	Installing Software on Debian Based Linux: Debian, Ubuntu, Kali Linux	
	1.2	Overview of Unix and Linux architectures, Linux files system, Linux standard directories, Linux Directory Structure, Basic Linux Commands, Linux Networking commands, Viewing Files and the Nano Editor, Editing Files in Vi, Graphical Editors, Deleting, Copying, Moving, and Renaming Files	
2.0		Linux OS	06
	2.1	Linux Design Principles, Linux Booting Process, Kernel Modules, Process Management, Scheduling, Memory Management, Input and Output, Inter-process Communication.	
3.0		System Administration	08
	3.1	Common administrative tasks, Configuration and log files, Role of system administrator, Managing user accounts –adding, deleting users, Changing permissions and ownerships, Creating and managing groups, Modifying group attributes.	
	3.2	Temporary disabling of users accounts, Creating and mounting file system, becoming super user using su, Getting system information with uname, host name. Disk partitions & sizes, users, kernel, installing and removing packages, rpm command	
4.0		Shell programming	12
	4.1	Basics of shell programming, various types of shell available in Linux, Shell programming in bash, Conditional statements, Looping statements, Case statements, Parameter passing and arguments	
	4.2	System shell variables, Shell variables, shell keywords, Creating Shell programs for automating system tasks, Scheduling repetitive jobs using cron.	
5.0		Linux Networking	08
	5.1	Basics of Network Management, Setting up Dynamic and Static Addressing, Monitoring network services, Talking with DNS Servers, Remote System Administration with OpenSSH-Server & Putty.	
	5.2	TCP/IP Networking for Linux System Administrators, DNS and hostnames, DHCP, , Network Troubleshooting.	
6.0		Servers and Configurations	10
	6.1	Create and configure DHCP, Mail, DNS, FTP, Squid, Apache, Telnet, Samba servers	
		Total	52

Suggested List of Experiments:

Sr.	Title
1	Linux Installation process using following method CD-ROM, Network Installation or Kickstart Installation.
2	Basic commands to create users, change permission, software selection and installation and do changes in Grub file.
3	Practical on configuration of Linux disk Management such as SWAP, LVM, RAID, Primary Partition, Extended Partition and Linux files system.
4	Write a shell script to show various system configuration like currently logged user and his logname, your current shell, home directory, operating system type, current path setting, current working directory, show currently logged number of users, show memory information, Hard disk information like size of hard-disk, cache memory, model etc, and file system mounted.
5	Write a shell script to add user and password on Linux system.
6	Write a shell script to print last login details.

7	Write a shell script to upgrade and cleans the system automatically instead of doing it manually.
8	Write a shell script to delete all log files present inside your var/log directory.
9	Write a script that accepts the hostname and IP address as command-line arguments and adds them to the /etc/hosts file.
10	Write a awk script to find the number of characters, words and lines in a file?
11	Write a shell script that delete all lines containing a specified word
12	write a shell script to find the factorial of given integer
13	Configuration of DHCP Server and Client
14	Configuration of DNS Server with Domain Name.
15	Configuration of NFS File server and transfer files to a windows client.
16	Setting up a Samba Server and creating a print server.
17	Configuration of Internet Server by creating a Proxy Server and configure browser to use as a proxy.
18	Configuration of Mail Server
19	Configuration of Web Server.
20	Configuration of FTP server and transfer files to demonstrate the working of the same.

Text books:

1. Yeswant Kanethkar – “UNIX Shell Programming”, First edition, BPB.
2. Cristopher Negus – “Red Hat Linux Bible”, Wiley Dreamtech India 2005 edition..
3. Jason Cannon ,”Linux for Beginners: An Introduction to the Linux Operating System and Command line”
4. W. Stevens , Stephen Rago , “Advanced Programming in the UNIX Environment”, Addison-Wesley Professional Computing Series

Reference books:

1. Official Red Hat Linux Users guide by Redhat, Wiley Dreamtech India
2. Graham Glass & King Ables – UNIX for programmers and users, Third Edition, Pearson Education.
3. Neil Mathew & Richard Stones – Beginning Linux Programming, Fourth edition, Wiley Dreamtech India.
4. Richard Petersen, Linux: The Complete Reference, Sixth Edition

Software Tools:

1. [Install Ubuntu desktop | Ubuntu](#)
2. [Chapter 4. Quick Installation Guide Red Hat Enterprise Linux 7 | Red Hat Customer Portal](#)
3. [Installation | Kali Linux Documentation](#)

Online Repository:

1. [How to Install a DHCP Server in Ubuntu and Debian \(tecmint.com\)](#)
2. [How to Install and Configure Postfix as a Send-Only SMTP Server on Ubuntu 16.04 | DigitalOcean](#)
3. [Network - DHCP | Ubuntu](#)

Term Work: At least **12 experiments** covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality. The experiments should be students centric as well as real time and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every Experiments are graded from time to time.

The grades will be converted to marks as per “Choice Based Credit and Grading System” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done. **The practical and oral examination will be based on entire syllabus.** Students are encourages to share their experiments codes on online repository. **Practical exam should cover all 12 experiments for examination.**

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM601	Mini Project 2B: FPGA based Project	--	04 ^{\$}	--	--	2	--	2

\$ Indicates work load of a learner (Not Faculty) for Mini Project 2B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECM601	Mini Project 2B: FPGA based Project	--	--	--	--	--	25	25	50

Course Pre-requisite:

1. ECC303 - Digital Design
2. ECM401- Mini Project 1B
3. ECC503- Digital VLSI

Course Objectives :-

1. To train students for FPGA based project implementation and management
2. To make students VLSI industry ready
3. To make students familiar with the Verilog Programming
4. To make students familiar with the targeted FPGA design and implementation
5. To familiarize students with the numerous FPGA solutions available in Market
6. To familiarize the students with the Interfacing of FPGA boards

Course outcomes :

1. Understand various FPGA families and method of FPGA synthesis and implementation
2. Learn the working of basic EDA tools like Xilinx, Modelsim cadence , etc
3. Able to program, simulate and synthesize circuits in Verilog HDL.
4. Learn the technique of interfacing of LED, switches and seven segment with FPGA.
5. Learn the project documentation, designing and handling techniques
6. Analysis of FPAG fault detection and verification principles

1. Guideline to maintain quality of mini project are as follows :

1. To achieve proper selection of Mini Projects. Students should do survey of FPGA boards, tools and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/ internal committee of faculties.
2. Students shall submit implementation plan in the form of Smart Report/Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
3. A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
4. Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

5. The solution to be verified with standard tools and procedures and report to be compiled in standard format of University of Mumbai.

6. **Suggested steps for mini project selection and implementation**

- i. Mini project should be completely FPGA based
- ii. Follow these steps
 1. Take specification, using these specifications design project.
 2. Select proper FPGA considering features and requirements of project. Create UCF file
 3. Program it using Verilog and write test benches for verification of each module
 4. Test Functional Simulation and verify it using simulation tool
 5. Synthesize, map and place and rout the design using synthesis tool
 6. Generate bit stream and download on FPGA
 7. Verify results on FPGA hardware/hardware setup made for project

2. **Project Topic selection and approval :-**

1. The group may be of maximum **FOUR (04)** students.
2. Topic selection and approval by **2 Expert** faculty from department at the start of semester
3. **Log Book** to be prepared for each group to record the work progress in terms of milestones per week by students. Weekly comment, remarks to be put by guiding faculty. Both students and faculty will put signature in it per week. The log book can be managed **online** with proper authentication method using google sheets/forms or open source project management software.

3. **Project Report Format:**

1. Report should not exceed **15 pages**. Simply staple it to discourage use of plastic.
2. The recommended report format is in LaTeX.

Term Work:

1. **Term Work evaluation and marking scheme:**

- a. The review/ progress monitoring committee shall be constituted by Head of Departments of each institute.
- b. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- c. At end of semester the above 2 expert faculty who have approved the topic will internally **evaluate the performance**.
- d. Students have to give presentation and demonstration on the FPGA Based Mini Project- 2-B
- e. In the evaluation each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed. Based upon it the marks will be awarded to student.
- f. **Distribution of 25 Marks scheme is as follows:**
 - i. Marks awarded by guide/supervisor based on log book : 10
 - ii. Marks awarded by review committee : 10
 - iii. Quality of Project report : 05

2. **Guidelines for Assessment of Mini Project Practical/Oral Examination:**

- a. Report should be prepared as per the guidelines issued by the University of Mumbai.
- b. Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and **External Examiners preferably from industry or research organisations** having experience of more than five years approved by head of Institution.
- c. Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to FPGA and Synthesis	04
	1.1	Compare FPGA, ASIC, SOC, Basic FPGA architecture, Compare various FPGA Boards**, Understanding VLSI Design flow	
	1.2	Understanding Tools : Functional simulation , Synthesis and implementation, Synthesis tool flow, Implementation and bit generation, making User constraint files (UCF)	
	1.3	Study Material : https://www.xilinx.com/support/university/ise/ise-workshops/ise-fpga-design-flow.html	
2.0		Writing First program in Verilog	04
	2.1	Introduction to Verilog: Module definition, port declaration, connecting ports, Writing first Testbench	
	2.2	Exercise : Program for All gates, Writing Test bench and UCF	
	2.3	Study Material: https://www.xilinx.com/support/university/ise/ise-teaching-material/hdl-design.html	
3.0		Combinational design Using VERILOG	08
	3.1	Gate Level Modelling, hierarchical name referencing, Data Flow Modelling: Continuous assignments, delay specification, expressions, operators, operands, operator types	
	3.2	Exercise: Programming and FPGA implementation of Adders, 4-bit adders, Mux and decoders, Interfacing LED , switches with FPGA	
	3.3	Study Material : https://onlinecourses.nptel.ac.in/noc20_cs63/preview	
4.0		Sequential design Using VERILOG	08
	4.1	Behavioral Modelling : Structured procedures, initial and always, blocking ‘and non-blocking statements, delay control, event control, conditional statements, multi way branching, loops, sequential and parallel blocks Advanced topics: Tasks and Functions, generic programming with parameters.	
	4.1	Exercise: Programming and FPGA implementation of Counters FFs and Shift registers Interfacing Seven Segment Display, UART with FPGA	
5.0		Project Outline	08
	5.1	Clocked Synchronous State-Machine Analysis, State-Machine Structure, Output Logic, Characteristic Equations Analysis of State Machines with D Flip-Flops, Clocked Synchronous State-Machine Design, Designing State Machines Using State Diagrams, State Tables	
	5.2	Project Design Steps: Designing state diagram, block diagram of project, Selection of FPGA for project, Selection of synthesis and simulation tool.	
6.0		Project Implementation and management	20
	6.1	Git Repositories, Learning of Project management software’s like CVS, SVN etc	
	6.2	Project Implementation: Verilog coding, simulation, Synthesis, Bit generation and downloading on FPGA. .	
	6.3	Result verification and testing	
		Total	52

Reference books:

1. Samir Palnitkar, “Verilog HDL A guide to Digital Design and Synthesis” , 2nd Edition, Pearson Education, 2009
2. Simon D Monk, “Programming FPGAs : Getting started with Verilog”, 1st Edition, McGraw Hill Education-2016
3. M. Morris Mano, Michael D. Ciletti , “Digital Design: With a Introduction to the Verilog Hdl”, Pearson Prentice Hall, 2013
4. David Romano, “Make: FPGAs: Turning Software into Hardware with Eight Fun and Easy DIY”, Shroff/Maker Media; First edition,2016
5. Frank Vahid, “Digital Design”, Wiley India Private Limited; Preview edition, 2009
6. Behrooz Parhami ,“COMPUTER ARITHMETIC Algorithms and Hardware Designs” , , Oxford University Press, 2010
7. Clive Maxfield ,“Design Warrior’s Guide to FPGA”, 2004, Elsevier

Reference links:

1. <https://www.sanfoundry.com/vlsi-questions-answers-aptitude-test/>
2. Free Tool : <https://www.edaplayground.com/>
3. <https://github.com/>

****Suggested FPGA Hardware Boards:**

1. Numato FPGA boards - <https://numato.com/shop/>
2. Papilio FPGA boards - <http://store.gadgetfactory.net/fpga/>
3. CMOD s6 - <https://store.digilentinc.com/cmod-s6-breadboardable-spartan-6-fpga-module/>
4. TinyFPGA - <https://tinyfpga.com/>
5. Zync,Zed Board - <https://www.xilinx.com/products/silicon-devices/soc/zynq-7000.html>
6. Artix -7, Kinetex Boards - <https://store.digilentinc.com/artix-a7-artix-7-fpga-development-board/>

Suggested Software tools:

1. Xilinx ISE Webpack
2. Modelsim/Questasim
3. Leonardo spectrum
4. MATLAB
5. Quartus
6. Actel
7. Icarus Verilog Simulator

Suggested Projects (FPGA downloading is must)

- 1) Shift-Add Multiplication,
- 2) Hardware Multipliers
- 3) Programmed Multiplication
- 4) Shift-Subtract Division
- 5) CORDIC Algorithm
- 6) Design of functions such as reciprocal, square root, sine, cosine, exponential
- 7) Wallace Multiplier
- 8) 8- Bit ALU
- 9) Matrix Multiplication
- 10) Booths Multiplier
- 11) NRZ,NRZI etc coding techniques

Suggested Courses

1. NPTEL Verilog Programming - Free
2. Workshops -Xilinx University Program- Freely available

Suggested Competitions for Funding

1. Government Swadeshi Microprocessor Challenge
2. IICDC – TI challenge
3. Sankalp Semiconductors Hackathons

UNIVERSITY OF MUMBAI



Bachelor of Engineering

in

Mechanical Engineering

Third Year with Effect from AY 2021-22

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year
2019–2020)



Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	Third Year B.E. in Mechanical Engineering
2	Eligibility for Admission	After Passing Second Year Engineering as per the Ordinance 0.6243
3	Passing Marks	40 %
4	Ordinances / Regulations (if any)	Ordinance 0.6243
5	No. of Years / Semesters	8 semesters
6	Level	P.G. / U.G./~~Diploma~~ / ~~Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / Semester (Strike out which is not applicable)
8	Status	~~New~~ / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	2021-2022

Date

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' Scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the Institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

When the entire world is discussing about 'Industry 4.0', we are at the crossroads. There are so many expectations from the graduating engineers, who shall be the major contributors to ecosystem for development of the Nation. Engineering education in India, in general, is being revamped so as to impart the theoretical knowledge along with industrial exposure. It is our attempt, when we are introducing a new curriculum; to bridge the industry-academia gap. To enable this, we have introduced components such as skill-based laboratories and project-based learning. We trust that this will allow the learner to apply knowledge gained in previous and current semesters to solve problems for gaining better understanding. What once were pure mechanical systems have now been transformed into multidisciplinary systems of mechatronics, electronics and computer science. Interdisciplinary knowledge is gaining importance as we are moving towards automated world as technology advances. Keeping this in mind the curriculum has been designed in a way so that learner shall be acquainted with many Interdisciplinary subjects.

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. The Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by several faculty members and Industry experts. The Program Educational Objectives proposed for the undergraduate program in Mechanical Engineering are listed below:

1. To prepare the stake holder to exhibit leadership qualities with demonstrable attributes in lifelong learning to contribute to the societal needs.
2. To make ready the stake holder to pursue higher education for professional development
3. To help the stake holder to acquire the analytical and technical skills, knowledge, analytical ability attitude and behavior through the program
4. To prepare the stakeholders with a sound foundation in the mathematical, scientific and engineering fundamentals
5. To motivate the learner in the art of self-learning and to use modern tools for solving real life problems and also inculcate a professional and ethical attitude and good leadership qualities
6. To prepare the stake holder to able to Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

We trust this revised version of syllabus come up to the expectations of all stakeholders. We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar	: Chairman
Dr. S. M. Khot	: Member
Dr. V. M. Phalle	: Member
Dr. Siddappa S.Bhusnoor	: Member
Dr. S.S. Pawar	: Member
Dr. Sanjay U. Bokade	: Member
Dr. Dhanraj Tambuskar	: Member

Program Structure for Third Year Engineering
Semester V & VI
UNIVERSITY OF MUMBAI
(With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
MEC501	Mechanical Measurements and Controls	3	--	3	--	3
MEC502	Thermal Engineering	3	--	3	--	3
MEC503	Dynamics of Machinery	3	--	3	--	3
MEC504	Finite Element Analysis	3	--	3	--	3
MEDLO501X	Department Level Optional Course – 1	3	--	3	--	3
MEL501	Thermal Engineering	--	2	--	1	1
MEL502	Dynamics of Machinery	--	2	--	1	1
MEL503	Finite Element Analysis	--	2	--	1	1
MESBL501	Professional communication and ethics –II	--	2*+2	--	2	2
MEPBL501	Mini Project – 2 A	--	4 ^{\$}	--	2	2
Total		15	14	15	07	22

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/ Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
MEC501	Mechanical Measurements and Controls	20	20	20	80	3	--	--	100
MEC502	Thermal Engineering	20	20	20	80	3	--	--	100
MEC503	Dynamics of Machinery	20	20	20	80	3	--	--	100
MEC504	Finite Element Analysis	20	20	20	80	3	--	--	100
MEDLO501X	Department Level Optional Course – 1	20	20	20	80	3	--	--	100
MEL501	Thermal Engineering	--	--	--	--	--	25	--	25
MEL502	Dynamics of Machinery	--	--	--	--	--	25	25	50
MEL503	Finite Element Analysis	--	--	--	--	--	25	25	50
MESBL501	Professional communication and ethics - II	--	--	--	--	--	25	25	50
MEPBL501	Mini Project – 2 A	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	125	100	725

* Theory class to be conducted for full class, \$ indicates work load of Learner (Not Faculty), for Mini Project;

SBL – Skill Based Laboratory
PBL – Project Based Learning

Department Level Optional Course – 1

Course Code	Department Level Optional Course – 1
MEDLO5011	Optimization Techniques
MEDLO5012	Design of Experiments
MEDLO5013	Computational Methods

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract/Tut.	Theory	Pract.	Total
MEC601	Machine Design	4	--	4	--	4
MEC602	Turbo Machinery	3	--	3		3
MEC603	Heating, Ventilation, Air conditioning and Refrigeration	3	--	3	--	3
MEC604	Automation and Artificial Intelligence	3	--	3	--	3
MEDLO602X	Department Level Optional Course – 2	3	--	3	--	3
MEL601	Machine Design	--	2	--	1	1
MEL602	Turbo Machinery	--	2	--	1	1
MEL603	Heating, Ventilation, Air conditioning and Refrigeration	--	2	--	1	1
MESBL601	Measurements and Automation	--	4	--	2	2
MEPBL601	Mini Project – 2 B	--	4 ^{\$}	--	2	2
Total		16	14	16	07	23

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/ Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
MEC601	Machine Design	20	20	20	80	3	--	--	100
MEC602	Turbo Machinery	20	20	20	80	3	--	--	100
MEC603	Heating, Ventilation, Air conditioning and Refrigeration	20	20	20	80	3	--	--	100
MEC604	Automation and Artificial Intelligence	20	20	20	80	3	--	--	100
MEDLO602 X	Department Level Optional Course – 2	20	20	20	80	3	--	--	100
MEL601	Machine Design	--	--	--	--	--	25	25	50
MEL602	Turbo Machinery	--	--	--	--	--	25	--	25
MEL603	Heating, Ventilation, Air conditioning and Refrigeration	--	--	--	--	--	25	25	50
MESBL601	Measurements and Automation	--	--	--	--	--	25	25	50
MEPBL601	Mini Project – 2 B	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	125	100	725

\$ indicates work load of Learner (Not Faculty), for Mini Project;

SBL – Skill Based Laboratory;
PBL – Project Based Learning

Department Level Optional Course – 2

Course Code	Department Level Optional Course – 2
MEDLO6021	Press Tool Design
MEDLO6022	Tool Engineering
MEDLO6023	Metal Forming Technology

Course Code	Course Name	Credits
MEC501	Mechanical Measurements and Controls	03

Objectives:

1. To study the principles of precision measuring instruments & their significance.
2. To familiarize with the handling & use of precision measuring instruments/ equipment's.
3. To impart knowledge of architecture of the measurement system.
4. To deliver working principle of mechanical measurement system.
5. To study concept of mathematical modelling of the control system.
6. To acquaint with control system under different time domain.

Outcomes: Learner will be able to...

1. Handle, operate and apply the precision measuring instruments / equipment's.
2. Analyze simple machined components for dimensional stability & functionality.
3. Classify various types of static characteristics and types of errors occurring in the system.
4. Classify and select proper measuring instrument for displacement, pressure, flow and temperature measurements.
5. Design mathematical model of system/process for standard input responses and analyse error and differentiate various types of control systems and time domain specifications
6. Analyse the problems associated with stability.

Module	Details	Hrs.
1	1.1 Introduction to Metrology, Need for inspection, Fundamental principles and definition, Standards of measurement, Errors in measurements, International standardization. 1.2 Limits, fits and tolerances of interchangeable manufacture, Elements of interchangeable system, Hole based and shaft based systems, Tolerance grades, Types of fits, General requirements of Go & No go gauging, Taylor's principle, Design of Go & No go gauges.	06
2	2.1 Principles of interference, Concept of flatness, Flatness testing, Optical flats, Optical Interferometer and Laser interferometer. 2.2 Surface texture measurement: importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters - Ra, Ry, Rz, RMS value etc., Surface roughness measuring instruments. 2.3 Screw Thread measurement: Two wire and three wire methods, Floating carriage micrometer. 2.4 Gear measurement: Gear tooth comparator, Master gears, Measurement using rollers and Parkinson's Tester.	08
3	3.1 Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs. 3.2 Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc.	06
4	4.1 Displacement Measurement: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder), Nozzle Flapper	08

	Transducer 4.2 Strain Measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors 4.3 Pressure Measurement: Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges 4.4 Flow Measurement: Bernoulli flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter 4.5 Temperature Measurement: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers	
5	5.1 Introduction to control systems, Classification of control system. Open loop and closed loop systems. 5.2 Mathematical modelling of control systems, concept of transfer function, Block diagram algebra 5.3 Transient and steady state analysis of first and second order system. Time Domain specifications. Step response of second order system. Steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs	06
6	6.1 Stability analysis: Introduction to concepts of stability, The Routh criteria for stability 6.2 Experimental determination of frequency response, Stability analysis using Root locus, Bode plot	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text/Reference Books:

1. Engineering Metrology, I.C. GUPTA, Dhanpat Rai Publications.
2. Engineering Metrology, R. K. Jain, Khanna Publisher.
3. Measurement Systems: Applications and Design, by EO Doebelin, 5th Edition, McGraw Hill
4. Mechanical Engineering Measurements, A. K. Sawhney, Dhanpat Rai & Sons, New Delhi
5. Instrumentation & Mechanical Measurements, A. K. Thayal
6. Control System Engineering by Nagrath I.J. and Gopal M, Wiley Eastern Ltd.
7. Modern Control engineering: by K. Ogata, Prentice Hall
8. Control systems by Dhanesh Manik, Cengage Learning
9. Engineering Metrology and Measurements by N V Raghavendra and L Krishnamurthy, Oxford University Press.
10. Instrumentation and Control System, W. Bolton, Elsevier
11. Experimental Methods for Engineers by J P Holman, McGraw Hills Int. Edition
12. Engineering Experimentation by EO Doebelin, McGraw Hills Int. Edition
13. Mechanical Measurements by S P Venkateshan, John Wiley & Sons

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/103/112103261/> - Principles of Mechanical Measurement, IIT Guwahati
<https://nptel.ac.in/courses/112/107/112107242/> - Mechanical Measurement System, IIT Roorkee
<https://nptel.ac.in/courses/112/106/112106138/> - Mechanical Measurements and Metrology, IIT Madras

Course Code	Course Name	Credits
MEC502	Thermal Engineering	03

Objectives

1. To study the heat transfer concepts applicable for steady state and transient conditions.
2. To study mathematical modeling and design concepts of heat exchangers.
3. To familiarize with the working of S.I. and C.I. engines and their performance.

Outcomes: Learner will be able to...

1. Analyze the three modes of heat transfer in engineering application.
2. Develop mathematical models for different modes of heat transfer.
3. Analyze performance parameters of different types of heat exchangers.
4. Identify and analyze the Transient heat Transfer in engineering applications.
5. Explain construction and working of different components of internal combustion engines.
6. Evaluate engine performance and emission characteristics.

Module	Details	Hrs
1	1.1. Modes of Heat Transfer: Mechanism of conduction, Convection and radiation heat transfer and it's Governing laws. 1.2. Generalized heat conduction equation in rectangular, cylindrical and spherical coordinates (only equations for cylindrical and spherical coordinates, no derivation). 1.3. Steady state heat conduction through plane wall, composite wall, cylinder, composite cylinder, sphere and composite sphere. Thermal contact resistance. Critical radius of insulation in cylinder and sphere.	07
2	2.1 Heat transfer from Extended Surfaces: Types of extended surfaces and its significance. Governing differential equation for fin (Finite, Infinite, and Insulated tips) and its solution. Fin efficiency and effectiveness. Analysis of Thermometric well. 2.2 Unsteady state heat transfer: Lumped heat capacity Analysis. Applications of unsteady state heat transfer, Thermal time constant.	06
3	3.1 Convection: Free and Forced convection. External Flow: Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent flow over a flat plate. Internal Flow: Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent flow in tubes. General thermal analysis: Constant heat flux and constant surface temperature. 3.2 Boiling and Condensation: Introduction to Different boiling regimes, Film condensation, Drop wise Condensation. 3.3 Radiation: Basics laws of radiation and heat exchange between two bodies.	07

4	4.1 Mass Transfer: Introduction to Mass Transfer, governing equations of mass transfer. Mass transfer coefficient. 4.2 Heat Exchangers: Types of heat exchangers, Overall heat transfer coefficient, LMTD, Effectiveness, Effectiveness – Number of Transfer Unit (ϵ- NTU) method, Correction factor for multi pass (up to 2 passes on shell and tube side) and cross flow heat exchanger.	07
5	5.1 Introduction to I.C. Engines and its Classification. Working of Four stroke and Two-stroke engines, Valve Timing Diagram. Fuel air cycles, Actual cycle. 5.2 Introduction to Fuel Supply, Ignition, combustion and knocking in SI Engines. MPFI in SI Engine. 5.3 Introduction to Fuel Injection system, Combustion and detonation in CI Engines.	06
6	6.1 Engine Testing and Performance: Measurement of various performance parameters, Performance characteristic of SI and CI Engine, Effect of load and speed on performance parameters, Heat balance sheet. 6.2 Engine Emission and Control: Sources of Engine Emissions, Constituents of S.I. and C.I. Engine exhaust and their effects on environment and health. Study of emission (Euro & Bharat stage) norms, Control methods for S.I and C I engine emissions.	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining content (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books:

1. Fundamentals of Heat and Mass Transfer by F.P. Incropera and D P deWitt, Wiley India 3rd Edition.
2. Introduction to thermodynamics and Heat transfer by YunusACengel 2ndEdition, McGraw Hill.
3. Fundamentals of Heat and Mass Transfer, M. Thirumaleshwar, Pearson Education India, 2009.
4. Introduction to Heat Transfer, Som S. K ,PHI Publication.
5. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press.
6. Heat and Mass Transfer, by R Rudramoorthy and L Malaysamy, 2nd Edition, PEARSON.
7. Heat Transfer by J P Holman, McGraw Hill.
8. Heat Transfer by S P Sukhatme, University Press.
9. Heat and Mass Transfer by PK Nag, TMH.
10. Internal Combustion Engines, Willard W.Pulkrabek, Pearson Education.
11. Internal Combustion Engines, Shyam Agrawal, New Age International
12. Internal Combustion Engine, Mathur and Sharma
13. Internal Combustion Engines, Mohanty, Standard Book House
14. Internal Combustion Engine, Gills and Smith
15. Internal Combustion Engines Fundamentals, John B. Heywood , TMH
16. Internal Combustion Engines, Gupta H N, 2nd ed, PHI
17. Internal Combustion Engine, V Ganesan, TMH
18. Introduction to Internal Combustion Engines, Richard Stone, Palgrave Publication, 4th Edition
19. Internal Combustion Engine, S.L. Beohar
20. Internal Combustion Engine, P.M Heldt.
21. Internal Combustion Engine, E.F. Oberi.
22. Internal Combustion Engine by Domkundwar

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/101/112101097/> - Heat and Mass Transfer, IIT Bombay

<https://nptel.ac.in/courses/112/105/112105248/> - Heat Exchangers: Fundamentals and Design Analysis, IIT Kharagpur

<https://nptel.ac.in/courses/112/104/112104033/> - Engine Combustion, IIT Kanpur

<https://nptel.ac.in/courses/112/103/112103262/> - IC Engines and Gas Turbines, IIT Guwahati

Course Code	Course Name	Credits
MEC503	Dynamics of Machinery	03

Objectives:

1. To acquaint with working principles and applications of Governors / Gyroscope
2. To study static and dynamic force analysis in the mechanisms
3. To familiarize with basics of mechanical vibrations
4. To study the balancing of mechanical systems

Outcomes: Learner will be able to...

1. Demonstrate working Principles of different types of governors and Gyroscopic effects on the mechanical systems
2. Illustrate basic of static and dynamic forces
3. Determine natural frequency of element/system
4. Determine vibration response of mechanical elements / systems
5. Design vibration isolation system for a specific application
6. Demonstrate basic concepts of balancing of forces and couples

Module	Details	Hrs.
1.	Governors and Gyroscopes: 1.1 Governors: Introduction to Centrifugal and Inertia governors, Study and Force analysis of Porter and Hartnell governors including Performance characteristics, Governors effort and power. 1.2 Gyroscope: Introduction, Gyroscopic couple and its effect on spinning bodies, naval ships during steering, pitching, rolling and their stabilization.	07
2.	2.1 Static and Dynamic force analysis of Slider crank mechanism (neglecting mass of connecting rod and crank), , Turning moment on crank shaft 2.2 Dynamically equivalent systems to convert rigid body into two mass with and without correction couple (Case study- Connecting rod)	05
3.	3.1 Basic Concepts of Vibration: Vibration and oscillation, causes and effects of vibrations, Importance of study of vibrations, Vibration parameters - springs, mass, damper, Motion- periodic, non-periodic, degree of freedom, static equilibrium position, vibration classification, steps involved in vibration analysis 3.2 Free Undamped Single Degree of Freedom Vibration System: Longitudinal, transverse, torsional vibration system, Methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's method	06
4.	4.1 Free Damped Single Degree of Freedom Vibration System: Introduction to different methods of damping, Study and analysis of 1) Viscous damped system (under damped, critically damped, over damped; Logarithmic decrement) 2) Coulomb's damping (Combined Viscous and Coulomb damping excluded) 4.2 Equivalent Single Degree of Freedom Vibration System: Conversion of multi-springs, multi masses, multi-dampers into a single spring and damper with linear or rotational co-ordinate system,	06
5.	5.1 Forced Single Degree of Freedom Vibratory System: Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper)	08

	5.2 Vibration Isolation and Transmissibility:Force Transmissibility, motion transmissibility, typical isolators & mounts. 5.3 Vibration Measuring instruments:Principle of seismic instruments, vibrometer, accelerometer - undamped and damped, Introduction to conditioning monitoring and fault diagnosis	
6.	6.1 Rotor Dynamics:Critical speed of single rotor, undamped and damped 6.2 Balancing:Static and Dynamic balancing of multi rotor system(up to four rotors), balancing of reciprocating masses in In-line engines(up to four cylinders) , Introduction to V-engines (excluding other radial engines)	07

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests.

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

Text/Reference Books:

1. Theory of Machines Thomas Bevan CSB Publishers & Distributors
2. Theory of Machines by Jagdishlal Metropolitan Book New Delhi, Company, Daryaganj, Delhi
3. Theory of Machines by S.S.Ratan Tata McGraw Hill , New Delhi
4. Theory of Machines by P.L.Bellaney Khanna publication, NewDelhi
5. Theory of Machines and Mechanisms by John J Uicker, Gordon R Pennock and Joseph E Shigley, Oxford University Press
7. Theory of Vibration with Applications, by W. Thomson, 2nd edition, Pearson Education
8. Mechanical Vibrations by S.S.Rao, fourth edition, Pearson Education
9. Mechanical Vibrations by G.K.Grover
10. Fundamentals of Mechanical Vibration by S.Graham Kelly, Tata McGraw Hill
11. Principles of Vibration by Benson H Tongue, 2nd Edition, Oxford University Press
12. Vibration Analysis by P. Srineevasan, TMH
13. Mechanical Vibrations- Schaum's outline series, William W.Seto, McGraw Hill
14. Theory and Practice of Mechanical Vibrations by J S Rao and K Gupta, New Age International
15. Elements of Vibration Analysis by Leonard Meirovitch, McGraw- Hill, New York

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/101/112101096/> - Dynamics of Machines, IIT Bombay

<https://nptel.ac.in/courses/112/107/112107212/> - Introduction to Mechanical Vibration, IIT Roorkee

Course Code	Course Name	Credits
MEC504	Finite Element Analysis	03

Prerequisite:

Knowledge of:

- Differential equations (Formulation and solution, Types-Ordinary, Partial, Order and degree of the DE and the boundary conditions)
- Matrix algebra (Matrix operations, gauss elimination method to get inverse the inverse of matrix)
- Basics of the core field (Governing laws, relationship between the various variables and constants –like in structural field stress-strain,Thermal field-temp, heat transfer rate etc

Objectives:

1. To understand the concepts of FEA and its applicability to different engineering field problems.
2. To understand the representation of the physical model into an equivalent FEA model and steps to solve it.
3. To acquaint with application of numerical techniques for solving problems.

Outcomes: Learner will be able to...

1. Solve differential equations using weighted residual methods.
2. Develop the finite element equations to model engineering problems governed by second order differential equations.
3. Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements.
4. Apply the basic finite element formulation techniques to solve engineering problems by using two dimensional elements.
5. Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system.
6. Use commercial FEA software, to solve problems related to mechanical engineering.

Module	Details	Hrs
1	Introduction: 1.1 Introductory Concepts: Introduction to FEM, Historical Background, General FEM procedure, Applications of FEM in various fields Advantages and disadvantages of FEM 1.2 Mathematical Modelling of field problems in engineering, Governing Differential equations, primary/secondary variables, boundary conditions-types-essential/natural etc. 1.3 Approximate solution of differential equations, Weighted residual techniques (Galerkin , Subdomain method).	05
2	FEA Procedure:(Pre-processing, Processing, Post-processing) 2.1 Discrete and Continuous Models, Weighted Residual Methods - Ritz Technique- Basic Concepts of the Finite Element Method. 2.2 Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom. 2.3 Minimization of a functional, Principle of minimum total potential, Piecewise Rayleigh-Ritz method, Formulation of 'stiffness matrix', assembly concepts to develop system equation.	08

3	One Dimensional Problems: 3.1 One dimensional second order equations - discretization-element types - linear and higher order elements -derivation of shape functions and stiffness matrices and force vectors. 3.2 Assembly of Matrices- solution of problems in one dimensional structural analysis, heat transfer and fluid flow (stepped and taper bars, fluid network, spring-Cart Systems) 3.3 Analysis of Plane trusses, Analysis of Beams	10
4	Two Dimensional Finite Element Formulations: 4.1 Introduction, three node triangular element, four node rectangular element 4.2 Natural coordinates and coordinates transformations: serendipity and Lagrange's methods for deriving shape functions for triangular element. 4.3 Convergence criterion, sources of errors	05
5	Two Dimensional Vector Variable Problems: 5.1 Equations of elasticity - Plane stress, plane strain and axi-symmetric problems 5.2 Jacobian matrix, stress analysis of CST.	06
6	Finite Element Formulation of Dynamics and Numerical Techniques: 6.1 Applications to free vibration problems of rod and beam, Lumped and consistent mass matrices. 6.2 Solutions techniques to Dynamic problems, longitudinal vibration frequencies and mode shapes, Fourth order beam equation, transverse deflections and natural frequencies of beams.	05

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text/Reference Books:

1. Textbook of Finite Element Analysis by Seshu P, Prentice Hall of India
2. Finite Element Method by J N Reddy, TMH
3. 'Introduction to Finite Elements in Engineering, Chandrupatla and Belegundu, Pearson Education
4. Finite Element Methods by R Dhanraj and K Prabhakaran Nair, Oxford University Press
5. A first course in Finite Element Method by Logan D L, Thomson Asia PvtLtd
6. 'Concepts and Applications of Finite Element Analysis by Cook R D, Malkus D S, Plesha ME, John- Wiley Sons
7. The Finite Element Method in Engineering by S. S. Rao, Butter Worth Heinemann
8. Fundamental Finite Element Analysis and Application with Mathematica and MATLAB Computations by M. Asghar Bhatti, Wiley India Pvt. Ltd.

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/104/112104193/>
<https://nptel.ac.in/courses/105/106/105106051/>
<https://nptel.ac.in/courses/112/104/112104115/>
<https://nptel.ac.in/courses/112/103/112103295/>
<https://nptel.ac.in/courses/112/106/112106135/>
<https://nptel.ac.in/courses/112/106/112106130/>
<https://nptel.ac.in/courses/105/105/105105041/>
<https://nptel.ac.in/courses/112/104/112104116/>

Course Code	Course Name	Credits
MEDLO5011	Optimization Techniques	03

Objectives:

1. To Understand the need and origin of the optimization methods.
2. To understand various linear, nonlinear and other optimization techniques.
3. To understand various multi criterion and multi-objective decision making methods.
4. To understand recent tools in optimization

Outcomes: Learner will be able to...

1. Identify the types of optimization problems and apply the calculus method to single variable problems.
2. Formulate the problem as Linear Programming problem and analyse the sensitivity of a decision variable.
3. Apply various linear and non-linear techniques for problem solving in various domain.
4. Apply multi-objective decision making methods for problem in manufacturing environment and other domain.
5. Apply multi criterion decision making methods for problem in manufacturing environment and other domain.
6. Apply Design of Experiments method for Optimization

Module	Details	Hours
1	Basic Concepts: Statement of the Optimization Problem, Basic Definitions, Optimality Criteria for Unconstrained Optimization, Optimality Criteria for Constrained Optimization, Engineering Application of Optimization, Classification of Optimization Problems. Classical Optimization Techniques: Single variable optimization	06
2	Linear Programming Problem: Formulation, Simplex method, Big M Method, Two Phase, Primal to Dual, Dual Simplex method, Sensitivity Analysis and applications of LP Transportation and Assignment Models.	08
3	Integer Programming Model: Gomory's cutting plane method, Branch & Bound Technique. Non L.P. Model: Lagrangian method & Kuhn tucker Method, Newton's method. Discrete Event Simulation: Generation of Random Variable, Simulation Processes, Monte-Carlo Technique.	08

4	Multi Objective Decision making (MODM) Methods: Introduction to Multi objective optimization, Traditional Techniques such as, quadratic programming, geometric programming, Numerical on goal programming and dynamic programming. Introduction to Non-traditional optimization Techniques such as Genetic Algorithm, particle swarm, genetic algorithms, simulated annealing and Techniques based on Neural network & Fuzziness (Only concepts)	08
5	Multi Criterion Decision-making (MCDM) Methods: Introduction to multi criterion optimization Simple Additive Weighting (SAW) Method Weighted Product Method (WPM) Analytic Network Process (ANP) Analytic Hierarchy Process (AHP) Method TOPSIS Method PROMETHEE	06
6	Robust Design Methods: DOE and Taguchi techniques Full Factorial Design: The basics of "full factorials", ANOVA, Factorial effects and plots, and Model evaluation Fractional Factorial Design: The one-half fraction and one-quarter of the 2^k design, The general 2^{k-p} fractional factorial design Application of related software (Minitab, Design Expert or MATLAB)	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text/Reference Books:

1. S.S. Rao, "Engineering Optimization - Theory and Practice", John Wiley and Sons Inc.
2. Ranjan Ganguli, "Engineering Optimization - A Modern Approach" Universities Press
3. Pablo Pedregal, "Introduction to Optimization", Springer
4. L.C. Jhamb, "Quantitative Techniques Vol. 1 and 2", Everest Pub. House
5. Pierre D.A., "Optimization, Theory with Application", John Wiley & sons.
6. R V Rao, "Decision Making in the Manufacturing Environment Using Graph Theory and Fuzzy Multiple Attribute Decision Making" (Springer Publication).

7. Ritter, H., Martinetz, T., & Schulten, K., Addison, "Neural Computation and Self-Organizing Maps"-Wesley Publishing Company
8. Douglas C. Montgomery, "Design and analysis of experiments"(John Wiley & Sons Inc.)
9. Saravanan R, "Manufacturing Optimization through Intelligent Techniques", Taylor & Francis (CRC Press)-2006.

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/101/112101298/> - Optimization from Fundamentals, IIT Bombay

Course Code	Course Name	Credits
MEDLO5012	Design of Experiments	03

Objectives: -

1. To obtain clear understanding of use of statistics in experimentation
2. To obtain clear understanding of scheme of experimentation and its effect on accuracy of experimentation
3. To obtain knowledge of how to analyze results from such investigations to obtain conclusions
4. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to...

1. Plan, design, and conduct experimental investigations efficiently and effectively;
2. Understand strategy in planning and conducting experiments;
3. Choose an appropriate experimentation scheme to evaluate a new product design or process improvement through experimentation strategy, data analysis, and interpretation of experimental results.

Module	Details	Hrs
1	Introduction, Background and Overview: A brief history of DOE-When to use DOE- Basic principles of DOE & Some typical applications. Overview of basic statistical concepts, Simple Comparative Experiments, Single Factor experiments, Randomized Blocks, Latin Square Designs and extensions. Testing of Hypothesis ('T' & 'F' test), Introduction to Factorial Designs, 2^k Designs.	06
2	Full Factorial Design: The basics of "full factorials", ANOVA, Factorial effects including interaction effects and plots	06
3	Two & Three Level Fractional Factorial Design: Objective, The one-half fraction and one-quarter of the 2^k design, 2^{k-p} fractional factorial design, 3-level & Mixed-level Factorials & Fractional Factorials.	08
4	The Robust Design: Basics of robust designs, Loss Function, Taguchi designs, Orthogonal Arrays, Linear Graphs and Interaction effects, Signal to Noise Ratio, Parameter Design, Tolerance Design, Robust design example.	08
5	Response Surface Methodology: First & second order experiments, Analysis of second-order response surfaces, Central composite designs, Plackett-Burman designs, process optimization & reliability improving experiments	06
6	Experiment Design According to Shainin, Multi-variate charts, components search, paired comparisons	06

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text/Reference Books:

1. Statistics for Experimenters, Box, GEP, Hunter, WG, and Hunter, JS, 1978, Wiley.
2. Empirical Model-Building and Response Surfaces, Box, GEP and Draper, NR 1987, Wiley.
3. Experimental Designs, Cochran, WG and Cox, GM, 1957, Wiley.
4. The Design of Experiments, 8th Ed., Fisher, RA, 1966, Hafner.
5. Design and Analysis of Experiments (Vol I), Hinkelmann, K and Kempthorne, O, 1994, Wiley.
6. Optimal Design of Experiments, Pukelsheim, F, 1993, Wiley.
7. Statistical Principles in Experimental Design, 2nd Ed., Winer, BJ, 1962, McGraw-Hill.
8. Engineering Methods for Robust Product Design: Using Taguchi Methods in Technology and Product Development, Fowlkes WY, Creveling CM, 1995, Addison-Wesley Publishing Company
9. Design and Analysis of Experiments, 5th edition, by D.C. Montgomery, John Wiley & Sons, New York, 2001
10. Total Quality Management, 4th Ed, Besterfield D.H., Carol Besterfield M, Mary Besterfield Sacre, Besterfield G.H., Urdhwareeshe H, Urdhwareeshe R, 2015, Pearson

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/110/105/110105087/> - Design and Analysis of Experiments, IIT Kharagpur

<https://nptel.ac.in/courses/111/104/111104075/> - Analysis of Variance and Design of Experiments-I, IIT Kanpur

<https://nptel.ac.in/courses/111/104/111104078/> - Analysis of Variance and Design of Experiments-II, IIT Kanpur

Course Code	Course Name	Credits
MEDLO5013	Computational Methods	03

Objectives:

1. Introduction to analytical and numerical techniques.
2. Application of mathematical modelling to mechanical systems.
3. Learn the significance of statistical techniques and data interpolation.

Outcomes: Learner will be able to...

1. Understand and develop mathematical models of physical systems.
2. Identify an appropriate mathematical formulation to linear algebraic equations.
3. Build an appropriate mathematical formulation to non-linear algebraic equations.
4. Evaluate and interpret the data regression, curve fitting and statistics.
5. Apply the numerical techniques and numerical schemes.
6. Formulate the concept of numerical methods in realistic applications.

Module	Details	Hrs
1	Introduction to Computational Methods Motivation and applications of Computational Methods. Computation and Error Analysis: Accuracy and precision; Truncation and round-off errors (Numericals); Binary Number System; Error propagation.	06
2	Linear Systems and Equations Matrix representation: Cramer's rule; Gauss Elimination. Matrix Inversion: LU Decomposition; Iterative Methods; Relaxation Methods; Eigen Values and Eigen Vectors.	06
3	Non Linear Algebraic Equations: Bracketing methods: Bisection, Regula-Falsi. Croust Method: LU Decomposition. Open methods: Secant, Fixed point iteration, Newton-Raphson; Multivariate Newton's method.	06
4	Regression and Curve Fitting Interpolation function; Cubic Splines; Multi regression analysis, polynomial regression. Statistical methods: Statistical representation of data, modeling and analysis of data, test of hypotheses. Fuzzy Logic: Introduction to fuzzy logic, Fuzzy Logic Systems Architecture, Case study of Mechanical system.	08
5	Integration and Integral Equations Newton Cotes Quadrature ODEs: Initial Value Problems Euler's methods; Predictor-corrector method (Adam's Moulton, Milne's Method) ODEs: Boundary Value Problems Finite difference Method; Finite Element Method, Finite Volume Method	07

6	Application of Numerical Methods Predict vibration response of components to intricate profile generated by different machine tools, Design next generation Formula One cars to working at the cutting edge of robotics, Predict behaviour of flows to estimation of heat transfer in complex scenarios; Crank Nicolson method – Solution of 1-D Wave equation.	06

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then
4. part (b) will be from any module other than module 3)
5. Only **Four questions need to be solved.**

Text/Reference Books:

1. S. P. Venkateshan & Prasanna Swaminathan, "Computational Methods in Engineering", Ane Books Pvt. Ltd., 1st Edition, (2014) ISBN: 978-0-12-416702-5.
2. Steven C. Chapra & Raymond P. Canale, "Numerical Methods for Engineers", Mc-Graw Hill Education, 8TH Edition, (2020), ISBN: 1260571386
3. Joe D Hoffman, "Numerical Methods for Engineers and Scientists", Second Edition, Marcel Dekker (2001) ISBN: 0-8247-0443-6.
4. M.K. Jain, S.R. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th Edition, New Age International Publishers, 2019.
5. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, Fifth Edition, 2012.
6. Rajesh Kumar Gupta, Numerical Methods – Fundamentals and Applications, Cambridge University Press, First Edition, 2019.
7. Gupta and Santosh K., "Numerical Methods for Engineers", 4th Edition, New Age International Publishers, 2019, ISBN: 9789387788794
8. Ferziger J. and M. Peric, "Computational Methods for Fluid Dynamics" 3rd Edition, Springer, (2001) ISBN: 9783540420743.
9. Versteeg H., and W. Malalasekera, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method" 2nd Edition, PHI (2007) ISBN: 9780131274983.

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/127/106/127106019/> - Numerical Methods for Engineers, IIT Madras
<https://nptel.ac.in/courses/111/107/111107105/> - Numerical Methods, IIT Roorkee
<https://nptel.ac.in/courses/111/106/111106101/> - Numerical Analysis, IIT Madras
<https://nptel.ac.in/courses/111/107/111107107/> - Numerical Methods: Finite Difference Approach, IIT Roorkee

Course Code	Course Name	Credits
MEL501	Thermal Engineering	01

Objectives:

1. To familiarize the concept of various modes of heat transfer through experimental approaches.
2. To make conversant of concept of heat transfer mechanisms in various engineering applications.
3. To acquaint with the various methods for measurement of engine performance and emission parameters.

Outcomes: Learner will be able to...

1. Estimate thermal conductivity of engineering materials.
2. Evaluate performance parameters of extended surfaces.
3. Analyze heat transfer parameters in various engineering applications.
4. Analyze engine performance and emission parameters at different operating conditions.

List of Experiments

Group A (any five)

1. Measurement of thermal conductivity of metal rod/ liquids/insulating powder.
2. Measurement of thermal conductivity of composite wall.
3. Performance analysis of extended surfaces under free and force convection.
4. Measurement of heat transfer coefficient for flow over flat surface in free/forced convection.
5. Measurement of heat transfer coefficient for flow through tubes in free/forced convection.
6. Verification of Stefan Boltzmann Law.
7. Measurement of emissivity of Grey surface.
8. Determination of time constant of different materials under unsteady state heat transfer.
9. Estimation of overall heat transfer coefficient and effectiveness of heat exchanger.

Group B (Any four)

1. Study of performance and emissions characteristics of a Single Cylinder, Four-Stroke, Petrol Start, Kerosene Engine at constant speed (Load Test).
2. Study of performance and emissions characteristics of a Single Cylinder, Four- stroke Diesel Engine at constant speed (With Electrical/ Rope Brake Dynamometer) (Load Test) along with Heat Balance Sheet.
3. Study of performance and emissions characteristics of a Single Cylinder/Multi Cylinder, Two/Fourstroke petrol Engine at constant Speed/Load.
4. Study of performance and emissions characteristics of a Single Cylinder/ Multi Cylinder, Two/Four stroke petrol Engine at constant Speed along with heat balance sheet.
5. Determination of frictional power and mechanical efficiency of the Multi-cylinder Petrol Engine by Morse test.
6. Study of performance and emissions characteristics of a Single Cylinder, Four- stroke Diesel Engine at constant speed along with Heat Balance Sheet (With Electrical/ Rope Brake Dynamometer) (Load Test) using alternative fuels.
7. Study of performance and emissions characteristics of a Single Cylinder/Multi Cylinder, Four-stroke Petrol Engine at constant speed/load along with Heat Balance Sheet (With Electrical/ Rope Brake Dynamometer) (Load Test) under dual fuel mode.

Assessment:

Term Work

Term work shall consist of the experiments as mentioned in group A and group B.

The distribution of marks for term work shall be as follows:

1. Laboratory work (Experiments): 20 marks
2. Attendance: 05 marks

Virtual Lab

<https://mfts-iitg.vlabs.ac.in/> - Fluid and Thermal Sciences Lab, IIT Guwahati

<https://vlab.amrita.edu/index.php?sub=1&brch=194> - Heat & Thermodynamics Virtual Lab, Amrita Vishwa Vidyapeetham

<http://vlabs.iitkgp.ernet.in/rtvlas/#> - Virtual Lab on Automotive Systems

Course Code	Course Name	Credits
MEL502	Dynamics of Machinery	01

Objectives:

1. To acquaint with working principles and applications of gyroscope and governors
2. To acquaint with the principles of vibration measuring instruments
3. To study balancing of mechanical systems

Outcomes: Learner will be able to...

1. Plot and analyze governor characteristics
2. Analyze gyroscopic effect on laboratory model
3. Estimate natural frequency of mechanical systems
4. Analyze vibration response of mechanical systems
5. Determine damping coefficient of a system
6. Balance rotating mass

Term Work: (Comprises part a and b)

- a) **List of Experiments: (Minimum Eight)**
- b) **Assignment:**

Sr. No.	Title of Experiment	Laboratory Sessions
1	Experiments on Governors- Porter Governor, Hartnell Governor	2 hrs
2	Experiments on Gyroscope	2 hrs
3	Determine natural frequency of compound pendulum, equivalent simple pendulum system.	2 Hrs.
4	Determine natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel	2 Hrs
5	Determine natural frequency and nodal points for single rotor and two-rotor vibratory system	2 Hrs
6	Experiment on whirling of shaft	2 Hrs
7	Determination of damping coefficient of any system/media	2 Hrs
8	Experimental balancing of single and multi-rotor system	2 Hrs
9	Measurement of vibration response of a system	2 Hrs
10	Vibration analysis of mechanical system using MATLAB/SCILAB/GNU Octave	2 Hrs

Minimum two problems on each of the following topics:

1. Governors and Gyroscope
2. Static and dynamic force analysis
3. Vibration, isolation and control
4. Vibration measuring instruments
5. Rotor dynamics

Project Based Learning may be incorporated by judiciously reducing number of assignments

Term Work The distribution of marks for term work shall be as follows:

- Laboratory work : 15 marks.
- Assignments : 05 marks.
- Attendance : 05 Marks.

Virtual Labs

<https://dom-nitk.vlabs.ac.in/List%20of%20experiments.html> – Dynamics of Machine Lab, NITK, Surathkal

<http://mdmv-nitk.vlabs.ac.in/#> - Machine Dynamics and Mechanical Vibrations Lab, NITK, Surathkal

<https://mv-iitg.vlabs.ac.in/> - Virtual Labs for Mechanical Vibrations, IIT Guwahati

Course Code	Course Name	Credits
MEL503	Finite Element Analysis	01

Objectives:

1. To familiarise FEA concept for practical implementation
2. To acquaint with FEA application software

Outcomes: Learner will be able to...

1. Select appropriate element for given problem
2. Select suitable meshing and perform convergence test
3. Select appropriate solver for given problem
4. Interpret the result
5. Apply basic aspects of FEA to solve engineering problems
6. Validate FEA solution

Term Work: (Comprises a and b)

- a. List of Experiments:** Students should use the commercial software or open source application programs, to verify the results obtained by manual calculations. The input data and output results of the problem solved using the computer programs (Minimum 6) should be included in the Journal.

The proposed list is given below:

1. Any two problems using bar element
2. Any two problems using truss element
3. Any two problems using CST element
4. Any two problem using axisymmetric element
5. Any one problem of free vibration analysis using bar element
6. Any one problem on steady state heat conduction
7. Any one problem for analysis of Beams.

While performing the analysis the students should understand the concepts of selection of element type, meshing and convergence of solution.(using approach of refining mesh and or order of the element)

- b. Course Project: (Any one task out of the following proposed list)**

A group of not more than four students, shall do

- 1) Finite Element Analysis of any mechanical engineering element /system, which involves element selection, assigning properties, meshing, assigning loads, and boundary conditions, analysis and result interpretation.
- 2) Develop the program to verify the results obtained by manual calculations for simple 1D/2D problems using Python, MATLAB programming platform etc.
- 3) Simulate a problem and validate the results with experimental results (the test rigs from Strength of material /Heat transfer/Dynamics of machine/fluid lab etc may be used for obtaining the experimental results)

The distribution of marks for term work shall be as follows:

Part a:10 marks.

Part b:10 marks.

Attendance: 05 Marks.

End Semester Practical/Oral examination

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Duration of practical examination is 2 hour
3. Distribution of marks for practical/viva examination shall be as follows:
 - a. Practical performance**15** marks
 - b. Oral..... **10** marks

Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.

Students work along with evaluation report to be preserved till the next examination.

Text/Reference Books:

1. Programming the Finite Element Method, I M Smith, D V Griffiths and Margetts WILEY Publications.
2. The Finite Element Method: Theory, Implementation, and Applications, Larson, Mats G., Bengzon, Fredrik, Springer
3. Introduction to Finite Element Analysis and Design by N. H. Kim, B. V. Sankar, and A. V. Kumar by Wiley publication
4. Finite Element analysis using ANSYS by Paleti Srinivas, Krishna Chaitanya, Rajesh Kumar Detti, PHI Publication.
5. Finite Element Analysis Theory and Application With ANSYS by Saeed Moaveni, Pearson Publication.
6. Introduction to Finite Element Analysis Using MATLAB and Abaqus By Amar Khennane, CRC Press publication

Course Code	Course Name	Credits
MESBL501	Professional Communication And Ethics - II	02

Objectives:

Learners should be able to:

1. Discern and develop an effective style of writing important technical/business documents.
2. Investigate possible resources and plan a successful job campaign.
3. Understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4. Develop creative and impactful presentation skills.
5. Analyse personal traits, interests, values, aptitudes and skills.
6. Understand the importance of integrity and develop a personal code of ethics.

Outcomes: Learners will be able to...

1. Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2. Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3. Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4. Deliver persuasive and professional presentations.
5. Develop creative thinking and interpersonal skills required for effective professional communication.
6. Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

MODULE	DETAILS	HOURS
MODULE 1 - ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)		
1.1. Purpose and Classification of Reports	Classification on the basis of: • Subject Matter (Technology, Accounting, Finance, Marketing, etc.) • Time Interval (Periodic, One-time, Special) • Function (Informational, Analytical, etc.) • Physical Factors (Memorandum, Letter, Short & Long)	06
1.2. Parts of a Long Formal Report	• Prefatory Parts (Front Matter) • Report Proper (Main Body) • Appended Parts (Back Matter)	
1.3. Language and Style of Reports	• Tense, Person & Voice of Reports • Numbering Style of Chapters, Sections, Figures, Tables and Equations	

	● Referencing Styles in APA & MLA Format ● Proofreading through Plagiarism Checkers	
1.4. Definition, Purpose & Types of Proposals	● Solicited (in conformance with RFP) & Unsolicited Proposals ● Types (Short and Long proposals)	
1.5. Parts of a Proposal	● Elements ● Scope and Limitations ● Conclusion	
1.6. Technical Paper Writing	● Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References) ● Language and Formatting ● Referencing in IEEE Format	
MODULE 2 - EMPLOYMENT SKILLS		
2.1. Cover Letter & Resume	● Parts and Content of a Cover Letter ● Difference between Bio-data, Resume & CV ● Essential Parts of a Resume ● Types of Resume (Chronological, Functional & Combination)	06
2.2 Statement of Purpose	● Importance of SOP ● Tips for Writing an Effective SOP	
2.3 Verbal Aptitude Test	● Modelled on CAT, GRE, GMAT exams	
2.4. Group Discussions	● Purpose of a GD ● Parameters of Evaluating a GD ● Types of GDs (Normal, Case-based & Role Plays) ● GD Etiquettes	
2.5. Personal Interviews	● Planning and Preparation ● Types of Questions ● Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) ● Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	
MODULE 3 - BUSINESS MEETINGS		
3.1. Conducting Business Meetings	● Types of Meetings ● Roles and Responsibilities of Chairperson, Secretary and Members ● Meeting Etiquette	02

3.2. Documentation	● Notice ● Agenda ● Minutes	
MODULE 4 -TECHNICAL/ BUSINESS PRESENTATIONS		
4.1. Effective Presentation Strategies	● Defining Purpose ● Analysing Audience, Location and Event ● Gathering, Selecting &Arranging Material ● Structuring a Presentation ● Making Effective Slides ● Types of Presentations Aids ● Closing a Presentation ● Platform Skills	02
4.2 Group Presentations	● Sharing Responsibility in a Team ● Building the contents and visuals together ● Transition Phases	
MODULE 5 - INTERPERSONAL SKILLS		
5.1. Interpersonal Skills	● Emotional Intelligence ● Leadership & Motivation ● Conflict Management & Negotiation ● Time Management ● Assertiveness ● Decision Making	08
5.2 Start-up Skills	● Financial Literacy ● Risk Assessment ● Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	
MODULE 6 - CORPORATE ETHICS		
6.1. Intellectual Property Rights	● Copyrights ● Trademarks ● Patents ● Industrial Designs ● Geographical Indications ● Integrated Circuits ● Trade Secrets (Undisclosed Information)	02
6.2. Case Studies	● Cases related to Business/ Corporate Ethics	

List of Assignments for Termwork

(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal

3. Meeting Documentation
4. Writing a Technical Paper/ Analysing a Published Technical Paper
5. Writing a SOP
7. IPR
8. Interpersonal Skills
9. Aptitude test (Verbal Ability)

Note:

1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end–semester presentation based on the book report.

Guidelines for Internal Assessment

Term Work	25 Marks
Assignments	10 Marks
Attendance	05 Marks
Presentation slides	05 Marks
Book Report (hard copy)	05 Marks
Internal Oral -	25 Marks

Oral Examination will be based on a GD & the Project/Book Report presentation.

Group Discussion	10 Marks
Project presentation (Individual Presentation)	10 Marks
Group Dynamics	05 Marks

Suggested Reading

1. Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill.
2. Bovée, C. L., & Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011). Personal development for life and work. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational Behaviour. Harlow, England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
8. Sanjay Kumar & PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Virtual Labs

<https://ve-iitg.vlabs.ac.in/>- Virtual English and Communication Virtual Lab, IIT Guwahati

<http://vlabs.iitb.ac.in/vlabs-dev/labs/communication/>- Professional Communication Virtual Lab, IIT Bombay

Course code	Course Name	Credits
MEPBL501	Mini Project - 2A	02

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to...

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.

- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
 - Marks awarded by guide/supervisor based on log book : 10
 - Marks awarded by review committee : 10
 - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
 - First shall be for finalisation of problem
 - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
 - First review is based on readiness of building working prototype to be conducted.
 - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
 - Identification of need/problem
 - Proposed final solution
 - Procurement of components/systems
 - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
 - First shall be for finalisation of problem and proposed solution
 - Second shall be for implementation and testing of solution.

]

Assessment criteria of Mini Project

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
 2. Clarity of Problem definition based on need.
 3. Innovativeness in solutions
 4. Feasibility of proposed problem solutions and selection of best solution
 5. Cost effectiveness
 6. Societal impact
 7. Innovativeness
 8. Cost effectiveness and Societal impact
 9. Full functioning of working model as per stated requirements
 10. Effective use of skill sets
 11. Effective use of standard engineering norms
 12. Contribution of an individual's as member or leader
 13. Clarity in written and oral communication
- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
 - In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Course Code	Course Name	Credits
MEC601	Machine Design	04

Objectives:

1. To study basic principles of machine design
2. To familiarize with use of design data books & various codes of practice
3. To acquaint with functional and strength design principles of important machine elements
4. To familiarize selection of standard elements such as rolling element bearings, belts etc.
5. To make conversant with preparation of working drawings based on designs

Outcomes: Upon successful completion of this course, the learner will be able to

1. Use design data book/standard codes to standardise the designed dimensions
2. Design Knuckle Joint, cotter joint and Screw Jack
3. Design shaft under various conditions and couplings
4. Select bearings for a given applications from the manufacturers catalogue.
5. Select and/or design belts and flywheel for given applications
6. Design springs, clutches and brakes

Module	Details	Hrs
1	Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design, Material properties and their uses in design, Manufacturing consideration in design, Design consideration of casting and forging, Basic principle of Machine Design, Modes of failures, Factor of safety, Design stresses, Theories of failures (Selection in the process of designing), Standards, I.S. Codes, Preferred Series and Numbers Thick Cylinders: Design of thick cylinders subjected to an internal pressure using Lame's equation	08
2	Design against static loads: Socket and Spigot Cotter joint, Knuckle joint, Bolted and welded joints under eccentric loading; Power Screw- Screw Jack.	08
3	3.1 Design against fluctuating loads: variables stresses, reversed, repeated, fluctuating stresses. Fatigue failure: static and fatigue stress concentration factors, Endurance limit-estimation of endurance limit, Design for finite and infinite life, Soderberg and Goodman design criteria, 3.2 Design of Shaft: power transmitting, power distribution shafts, Module (excluding crank shaft) under static and fatigue criteria. Keys: Types of Keys and their selection based on shafting condition. Couplings: Classification of coupling, Design of Flange couplings, Bush pin type flexible couplings	12
4	4.1 Rolling Contact Bearings: Types of bearing and designation, selection of rolling contact bearings based on constant / variable load & speed conditions (includes deep groove ball bearing, cylindrical roller, spherical roller, taper roller, self-aligning bearing and thrust bearing) 4.2 Sliding Contact Bearings: Design of hydro dynamically lubricated bearings (self-contained), Introduction to hydro static bearings,	08
5	5.1 Design and selection of Belts: Flat and V-belts with pulley construction. 5.2 Design and selection of standard roller chains. 5.3 Design of Flywheel – Introduction, Fluctuation of energy and speed, turning moment	08

	diagram, estimating inertia of flywheel for reciprocating prime movers and machines, Weight of the flywheel, flywheel for punches, rim constructions, stresses in rims and arms, Construction of flywheel.	
6	6.1 Design of Springs: Helical compression, Tension Springs under Static and Variable loads, Leaf springs. 6.2 Design of Clutches: Introduction, types, Basic theory of plate and cone type clutches, Design of single plate, multi-plate and with spring, lever design and thermal, wear considerations. 6.2 Design of Brakes: Design of single shoe brake.	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

Text/Reference Books:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Machine Design by Pandya & Shah, Charotar Publishing
5. Mechanical Engineering Design by J.E. Shigley, McGraw Hill
6. Machine Design by Reshetov, Mir Publication
7. Machine Design by Black Adams, McGraw Hill
8. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
9. Machine Design by R.C. Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co
10. Design of Machine Elements by V.M. Faires
11. Design of Machine Elements by Spotts
12. Recommended Data Books – Design Data: Data Book of Engineers by PSG College, Kalaikathir Achchagam

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/105/112105124/> - Design of Machine Elements, IIT Kharagpur

<https://nptel.ac.in/courses/112/106/112106137/> - Machine Design-II, IIT Madras

Course Code	Course Name	Credits
MEC602	Turbo Machinery	03

Objectives

1. To apply principles of thermodynamics and fluid mechanics to turbomachines.
2. To learn the design and significance of various components of the turbomachine.
3. To estimate various parameters related to turbo machines using the governing equations.
4. To evaluate the performance of turbo machines.

Outcomes: Learner will be able to...

1. Define various parameters associated with steam generators and turbo machines.
2. Identify various components and mountings of steam generators with their significance.
3. Identify various turbo machines and explain their significance.
4. Apply principles of thermodynamics and fluid mechanics to estimate various parameters like mass flow rate power, torque, efficiency, temperature, etc.
5. Evaluate performance of SG and Turbo machines and apply various techniques to enhance performance.
6. Evaluate various phenomena related to performance like cavitation, choking, surging.

Module	Details	Hrs
1	1.1 Steam Generators- Layout of Thermal Power Plant, Classification of boiler, Difference between Fire tube and Water tube boiler with examples, Low pressure and high pressure boilers, once through boiler, important features of HP boilers, Mountings and accessories, Equivalent evaporation of boilers, Boiler performance, Boiler efficiency.	04
	1.2 Introduction to turbo machines: 1.2.1 Review of Thermodynamic principles, compressible gas flow relations, estimation of non-dimensional performance parameters for incompressible flow, specific speed. 1.2.2 Basic Euler's theory of turbo machines and its application to pumps, turbines and compressors.	04
2	Hydraulic Turbines: Basic theory, classification of turbines, theory of impulse and reaction turbines, estimation of work done, efficiency, characteristics of turbines, concept of draft tube and its types	06
3	Pumps 3.1 Classification of pumps, definition of pumping systems and system characteristics.	02
	3.2 Centrifugal pumps: Construction, estimation of work done, efficiency, characteristics, determination of operating point, cavitation and NPSH, specific speed of pumps	04
	3.3 Positive Displacement pumps-	04

	Types and applications, general feature of reciprocating pumps, definition of head, discharge, work done and efficiency, types of reciprocating pumps, indicator diagram (no numerical on reciprocating pump). Use of air vessel (only application no numerical).	
4	Air compressor- Introduction and general classification of reciprocating compressor- positive displacement, Multi Staging of reciprocating compressor (no derivation, numerical on single stage and two stage compressor). Centrifugal compressor, surging and choking of compressor (No numerical on centrifugal compressor).	04
5	Steam Turbine- Basic of steam turbine, Classification, compounding of turbine, Impulse turbine –velocity diagram, Condition for max efficiency Reaction turbine, Numerical on Simple Impulse turbine (De-Laval turbine) of single stage only. Degree of reaction, Parson's turbine, Condition for maximum efficiency, Numerical on Parson's turbine only.	06
6	6.1 Gas Turbines Applications of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration, Effect of operating variable on thermal efficiency and work ratio 6.2 Jet Propulsion Engines Classification of jet propulsion engines, Thrust, Thrust power, Propulsive efficiency and thermal efficiency.	05

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text Books:-

1. Thermal Engineering, AjoyKumar, G. N Sah, Narosa Publishing House, New Delhi
2. Fluid Mechanics and Machinery; CSP Ojha, R. Berndtsson, Oxford University.
3. Fluid Mechanics and Fluid Machines by Gautam Biswas, S K Som, Suman Chakraborty - Tata McGraw-Hill Education Pvt. Ltd.
4. Turbines, Compressors and Fans by S.M. Yahya, McGraw-Hill Education Pvt. Ltd.

5. Turbomachinery Design and Theory by Aijaz and Gorla
6. Fluid Mechanics, thermodynamics of turbomachinery- S.L.Dixon,
7. Amsterdam; Boston: Elsevier-Butterworth-Heinemann

Reference Books:-

1. R.K.Rajput; Engineering Fluid Mechanics; S. Chand publications.
2. Dr. Mody& Seth; Hydraulics and Fluid Mechanics; Standard book house
3. S. Ramamrutham, Hydraulic, Fluid Mechanics & Fluid Machines, Dhanpat Rai publishing company.
4. Streeter, Fluid Mechanics, Tata McGraw Hill.
5. Thermal Engineering, R K. Rajput, Laxmi Publication
6. Fluid Mechanics: Fundamentals and application; Yunus A Cengel and John M CimbalaPublisher: Special India

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/106/112106303/> - Introduction to Turbomachines, IIT Madras

<https://nptel.ac.in/courses/112/106/112106200/> - Fluid Dynamics and Turbomachines, IIT Madras

Course Code	Course Name	Credits
MEC603	Heating,Ventilation,Air Conditioning and Refrigeration	03

Objectives:

1. Learning the fundamental principles and different methods of refrigeration and air conditioning
2. Study of various refrigeration cycles and evaluate performance of each cycle.
3. Study of components of refrigeration and air-conditioning systems along with the applications.

Outcomes: Learner will be able to...

1. Illustrate the fundamental principles and applications of refrigeration and air conditioning systems.
2. Identify various HVAC&R components
3. .Evaluate performance of various refrigeration system
4. E stimate cooling and heating loads for an airconditioning system.
5. Select air handling unit & design air distribution system
6. Apply the knowledge of HVAC for the sustainable development of refrigeration and airconditioning systems.

Module	Details	Hrs
1.	1.1 BasicKnowledge:CarnotrefrigeratorCarnot h ,eat pumpCarnot,coefficient of performance,Reversed Carnot cycle,and its limitaionEffect of temperature and pressure on COP of the cycle 1.2 Refrigerants: Classification,Designation,Selection of refrigerant,Physical and chemical pproperties of rrefrigerants ,Secondaryrrefrigerants 1.3 Air Refrigeration System: Bell Coleman cycle, Necessity of air cooling, Factors considered for the selection of air refrigeration system, Types of air refrigeration system with schematic and T-Sdiagram, Numerical based on simple and bootstrap air refrigeration system.	06
2.	2.1 VapourCompression Refrigeration System: Simple system on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, actual cycle, Numerical based on standard vapour compression system byusing P-h chart .and refrigerant table 2.2 Vapour Absorption Refrigeration System. Simple and practical,vapour absorption systemRefrigerant-adsorbent properties, COP of ideal vapour absorption system, DomesticElectroluxrefrigerator, Lithiumbromideabsorption system. 2.3 :Heat Pump performance,Primary energy ratio,Energy efficiency Introduction,Coefficient of ratio,Heating season performance factor,Seasonal energy efficiency ,ratio,Classification of heat pump,Vapour compression heat pump systemsHeat pump application in an industry.	08

3.	3.1 Thermal Comfort Conditions: Selection of inside design conditions, thermal comfort, heat balance equation for a human being, factors affecting thermal comfort, Effective temperature, comfort chart and factors governing effective temperature, selection of outside design conditions 3.2 Psychrometry: of Air Conditioning Processes Psychrometry properties, relations and processes, Adiabatic air mixing, process Psychrometric chart, RSHP, GSHF, ERSHP, Bypass factor, Apparatus dew point Numerical based on psychrometric chart and . Classification of air conditioning system, relations 3.3 : Cooling Load Estimation Introduction, Components of cooling load Different heat sources, various load Estimation, Design of air conditioning system Building survey and economic, aspect used in design.	10
4.	4.1 Air Distribution System: 4.1.1 : Duct Classification of ducts, duct material, pressure in ducts, flow through duct, pressure losses in duct, air flow through simple duct system, equivalent diameter, Methods of duct system design: 4.1.2 : Air Handling Unit Introduction, Fan coil unit, Types of fans used in air conditioning applications, Fan laws, filters, supply and return grills, Sensors.	06
5.	5.1 HVAC & Components Working of reciprocating, screw and scroll compressors, working of air cooled, and water cooled and evaporative condensers, Working of DX, Flooded, and Forced feed evaporators, Expansion devices Capillary tube, TXV, EXV, Type of insulation materials.	06
6.	6.1 Application of HVAC & R Ice plant, Food storage plants, dairy and food processing plants, freeze drying, A/c in textile, Printing pharmaceutical industry and Hospitals, Cold chain Technology, Transport air conditioning, Solar refrigeration.	03

Assessment:

- **Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on approximately 40% but excluding contents covered in Test I

- **End Semester Examination:**

1. Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
2. Question paper will comprise of total **six questions, each carrying 20 marks**
3. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
4. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
5. Only **Four questions need to be solved**

Text/Reference Books:-

1. Refrigeration and Air Conditioning by C.P.Arora, McGraw Hill education (India) (P) limited, New Delhi
2. Principles of Refrigeration by Roy J. Dossat, Pearson education, New Delhi
3. Refrigeration and Air Conditioning by Manohar Prasad, New age international (P) limited, New Delhi
4. Refrigeration and Air Conditioning by S.C.Arora and S.Domkundwar, Dhanpatrai and sons, Delhi
5. Khurmi R.S. and Gupta J.K., Refrigeration and Air conditioning, Eurasia Publishing House Pvt. Ltd, New Delhi
6. ISHRAE Air Conditioning Handbook
7. ISHRAE Refrigeration Handbook
8. ASHRAE Handbook of Fundamentals
9. ASHRAE Handbook of Equipment
10. ASHARE Handbook of System
11. Open Source Software/learning website

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/107/112107208/> - Refrigeration and Air Conditioning, IIT Roorkee
<https://nptel.ac.in/courses/112/105/112105128/> - Refrigeration and Air Conditioning, IIT Kharagpur

Course Code	Course Name	Credits
MEC604	Automation and Artificial Intelligence	03

Objectives:

1. To understand the need and justification of automation.
2. To study design of pneumatic and hydraulic circuits.
3. To study and understand electropneumatic circuits and PLC Design
4. To familiarize with robotic systems in automated manufacturing processes.
5. To study and understand AI and machine learning technologies for automation.

Outcomes: Learner will be able to...

1. Demonstrate understanding of fundamentals of industrial automation and AI.
2. Design & develop pneumatic / hydraulic circuits.
3. Design and develop electropneumatic circuits and PLC ladder logics.
4. Demonstrate understanding of robotic control systems and their applications.
5. Demonstrate understanding of various AI and machine learning technologies.

Module	Details	Hrs
1	1.1 Introduction to Automation Definition and fundamentals of automation, Elements of Automated system, Automation principles and strategies, Levels of automation, types of automation, Advanced automation functions 1.2 Introduction to Artificial Intelligence Introduction, Historical development, Intelligent Systems, Types of Intelligent Agents, Components of AI, Foundations of AI, Scope of AI, Current trends in AI, Relevance to Mechanical Engineering	04
2	2.1 Design of Pneumatic Circuits Design of Pneumatic sequencing circuits using Cascade method and Shift register method (up to 2 cylinders) 2.2 Design of Hydraulic Circuits Basic Hydraulic Circuits: Meter in, meter out and Bleed off circuits; Intensifier circuits, Regenerative Circuit, Counter balance valve circuit and sequencing circuits.	08
3	3.1 Electro-pneumatic Circuits Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping; 3.2 PLC Discrete Control Systems Design of Pneumatic circuits using PLC Control (ladder programming only) up to 2 cylinders, with applications of Timers and Counters and concept of Flag and latching.	08
4	Robots and their applications: Introduction to Robots, Types, Classifications, Selection of Robots, Robot Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a Robot, Robot feedback controls: Point to point control and Continuous path control, Control system for Robot joint, Adaptive control, Drives and transmission systems, End effectors, Industrial robot applications, Nex-gen robots.	07

5	(Concept and Algorithms, No programming or numericals) 5.1 Problem Solving: Tree and Graph Search, Uninformed v/s informed search, uninformed methods: depth first search, breadth first search, Informed search: heuristic search, Best first search, branch and bound 5.2 Machine Learning: Introduction, types of machine learning: supervised, unsupervised, reinforcement learning 5.3 Learning with Decision Trees: Introduction to Decision Trees, Classification and Regression Trees, K means clustering algorithm, K nearest neighbours algorithm, hierarchical clustering, Concept of ensemble methods: bagging, boosting, random forests	06
6	(Concept and Algorithms, No programming or numericals) 6.1 Learning with regression: Linear regression, Logistic regression 6.2 Artificial Neural Networks Concept of ANN, Basic Models of Artificial Neural Networks Important Terminologies of ANNs McCulloch-Pitts Neuron, NN architecture, perceptron, delta learning rule, backpropagation algorithm, Gradient Descent algorithm, feed forward networks, activation functions 6.3 Introduction to AI Technologies in the realm of Automation Concept of Natural Language Processing, Machine Vision, Deep learning, Expert systems, Genetic Algorithms, Industry 4.0	06

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text/Reference Books:

1. Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
2. Mechatronics System Design , Shetty and Kolk, Cengage Learning, India Edition
3. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton Pearson education
4. Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
5. Pneumatic Circuits and Low Cost Automation by Fawcett JR
6. Electromechanical Design Handbook , Walsh, McGraw-Hill
7. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
8. Industrial Hydraulics: Pippenger

9. Vickers Manual on Hydraulics
10. Hydraulic Valves and Controls: Pippenger
11. Fundamentals of pneumatics: Festo series
12. Mechatronics, NitaigourMahalik, Tata McGraw-Hill
13. Mechatronics, HMT
14. M.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education, New Delhi
15. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, “Industrial Robotics Technology programming and Applications”, McGraw-Hill,
16. Yoram Korean, “Robotics for engineers”, McGraw Hill Co
17. John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications", Prentice Hall.
18. Frank Petruzella, " Programmable Logic Controllers", McGraw-Hill Education; 4 edition
19. Artificial Intelligence: A Modern Approach by Peter and Norvig ISBN-0-13103805-2,
20. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair ISBN-978-0-07008770-5, TMH,
21. Artificial Intelligence by Saroj Kausik ISBN:- 978-81-315-1099-5, Cengage Learning
22. Artificial Intelligence and Intelligent Systems by Padhy, Oxford University Press,
23. Artificial Intelligence & Machine Learning by Vinod Chandra .S.S. Anand Harindran. S. (PHI)
24. A first course in Artificial Intelligence – By Deepak Khemani. McGrawHill

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/103/112103174/>

<https://nptel.ac.in/courses/112/103/112103293/>

<https://nptel.ac.in/courses/112/102/112102011/>

<https://nptel.ac.in/courses/112/101/112101098/>

<https://nptel.ac.in/courses/112/103/112103280/>

<https://nptel.ac.in/courses/106/106/106106139/>

Course Code	Course Name	Credit
MEDLO6021	Press Tool Design	03

Objectives:

1. To acquaint with various press working operations for mass production of sheet metal components
2. To familiarise with sheet metal working techniques for design of press tools
3. To inculcate knowledge about scrap minimization, safety aspects and automation in press working

Outcomes: Learner will be able to....

1. Demonstrate various press working operations for mass production of sheet metal parts
2. Identify press tool requirements to build concepts pertaining to design of press tools
3. Prepare working drawings and setup for economic production of sheet metal components
4. Select suitable materials for different elements of press tools
5. Illustrate the principles and blank development in bent & drawn components
6. understand safety aspects and automation in press working

Module	Details	Hrs
1	Introduction to Press Working 1.1 Classification of common Press working operations, Benefits and limitations of using Press tools. Applications of pressed parts/components. 1.2 Theory of Shearing in Press Working. Optimum Cutting clearance & its effect on tolerances of pressed components. Press working terminology, Functions of different elements of a press tool. material handling equipment, Methods of feeding the strip/coil material.	6
2	Design Progressive die 2.1 Calculations for Economic Strip Layout, Calculations of Cutting force and Stripping force, recommending minimum tonnage of a press, Methods of reducing cutting loads on press tools 2.2 Design aspects of Press tool elements viz. Punches & methods of mounting punches, types of Die block, Stripper, Pilot, stock guides, stock stops, Selection and arrangement of Hardware used in Press tools. Selection of steels and its hardness for different elements of Press tools. 2.3 Centre of pressure, Different types Die sets and its selection, shut height of die, Problems based design of progressive die	10
3	Bending and Drawing- 3.1 Theory of Bending, Spring back and measures to control it, Calculations for Blank development of Simple Bent components, Minimum bend radius, Types of Bending dies, roller bending, bending force problems on bend length calculation and bending force, 3.2 Theory of Drawing, Metal flow in Drawing & forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup, problems on drawing 3.3 Defects in drawn parts 3.4 Basic construction and working of Bending and Drawing dies	8

4	Miscellaneous Dies- Basic construction & working of Shaving dies, Trimming dies, Compound dies, Combination dies, Coining dies, Embossing dies, Simple Progressive & Compound Progressive dies, drop through and inverted die, curling die, transfer die	4
5	Selection of Presses and its setting Classification of presses, Selection of Press and Press setting, calculation of shut press shut height and die shut height, Overloading of presses (load, energy considerations)	4
6	Introduction to Automation & Safety in Press shop Types of CNC Press, Types of CNC press controller, Basic hydraulic and pneumatic circuit used in press for stock feeding and ram movement, different types sensors used for hand protection, stock feeding etc., other safety equipment like break, clutch, face shield etc.	4

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books

1. Die Design Fundamentals by J. R. Paquin, Industrial Press
2. Techniques of Press Working Sheet Metal by D F Eary and E A Reed
3. Press Tools Design and Construction by P H Joshi, S Chand Publishing
4. Tool Design by C. Donaldson and V C Goold, TMH
5. Production Engineering by P. C. Sharma, S Chand Publishing
6. Metal working ASM Handbook

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/105/112105233/> - Metal Cutting and Machine Tools, IIT Kharagpur

Course Code	Course Name	Credit
MEDLO6022	Tool Engineering	03

Objectives :

1. To familiarize with the basic concepts of machining science like mechanics of machining, tool wear, tool life, surface roughness and tool materials.
2. To familiarize with various single and multipoint cutting tools designing processes
3. To study the economics of machining process

Outcomes: Learner will be able to...

1. Calculate the values of various forces involved in the machining operations
2. Design various single and multipoint cutting tools
3. Analyze heat generation in machining operation and coolant operations
4. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
5. Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish
6. Analyze economics of machining operations

Module	Details	Hrs
1	1.1 Metal Cutting Theory: Orthogonal and oblique cutting, various types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations, Concept of specific power consumption in machining, Ernst and Merchant's model & modified model for orthogonal cutting, problems on above topic. 1.2 Dynamometry: Dynamometer requirements, force measurement, electric transducers, strain gauge lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, piezoelectric dynamometry	08
2	2.1 Temperatures in metal cutting and cutting fluids: Heat generation in metal cutting, heat transfer in a moving material, temperature distribution in metal cutting, effect of cutting speed on temperature, prediction of temperature distribution in machining, measurement of cutting temperature, work tool thermocouple, direct thermocouple measurement, radiation methods, hardness changes in steel tools, Cutting fluid types, the action of coolants, the action of lubricants, characteristics of an efficient lubricant in metal cutting, application methods of cutting fluid, dry cutting and minimum quantity lubrication, cryogenic cooling, cutting fluid maintenance and environmental considerations, disposal of cutting fluids	05
3	Cutting tool materials and machining induced surface integrity 3.1 Properties of cutting tool materials, Major tool material types, Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools, Techniques for manufacturing coated tools 3.2 Measurement and specification of surface finish, primary cutting edge finish, fracture roughness, BUE formation and its influence on finish, secondary cutting edge finish,	04

4	Tool life and Machining Economics: 4.1 Definition, tool wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life, Taylor's tool life equation, machinability of material, factors affecting machinability, 4.2 Components of product cost, Optimum cutting velocity for minimum cost of production and maximum production rate, problems on above topic.	06
5	Design of single point cutting tools: Different systems of tool nomenclature like MRS and ORS, Constructional features of solid tool, tipped tools, mechanically held regrindable insert type tools and throw away tip type tools, Design of shanks, cutting tip and chip breakers for HSS and Carbide tools, ISO coding system for tipped tools and tool holders, Tool design for EDM and USM.	05
6	Design of multi point cutting tools: Introduction to various form tools, Broach nomenclature, design steps for circular pull type, key way and spline broaches, Design of face and peripheral milling cutters, Drill, Reamer and Tap design using standard procedure.	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books

1. Fundamentals of Metal Machining and Machine Tools, Third Edition by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group
2. Metal Cutting Principles by Milton Clayton Shaw, 2nd Edition, Oxford University Press
3. Cutting Tools by P H Joshi, A H Wheeler Publishing Co Ltd
4. ASM Handbook, Vol. 16: Machining by Joseph R. Davis, 9th Edition, ASM International
5. Fundamentals of Metal Cutting and Machine Tools by B. L. Juneja, G. S. Sekhon and Nitin Seth, 2nd Edition, New Age International
6. Metal Cutting Theory and Cutting Tool Design, by V. Arshinov and G. Alekseev, Mir publishers, Moscow
7. Typical Examples and Problems in Metal Cutting and Tool Design, by N. Nefedov and K. Osipov, Mir publishers, Moscow
8. Production Technology – HMT handbook

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/105/112105233/> - Metal Cutting and Machine Tools, IIT Kharagpur

Course Code	Course Name	Credits
MEDLO6023	Metal Forming Technology	03

Objectives:

1. To conversant with the basic knowledge on fundamentals of metal forming processes
2. To study various metal forming processes
3. Understanding plastic deformation and technical analysis of forming processes

Outcomes: Learner will be able to...

1. Understand the concept of different metal forming process.
2. Approach metal forming processes both analytically and numerically
3. Design metal forming processes
4. Develop approaches and solutions to analyze metal forming processes and the associated problems and flaws.

Module	Details	Hrs
1.	Introduction to Metal Forming: Metallurgical aspects of metal forming, slip, twinning mechanics of plastic deformation, effects of temperature, strain rate, microstructure and friction in metal forming-yield criteria and their significance, Classification of Metal Forming Processes, Advantages and Limitations, Stress strain relations in elastic and plastic deformation, concept of flow stresses, deformation mechanisms, Hot and Cold Working Processes and Its Effect on Mechanical Properties.	08
2.	Rolling: Introduction and Classification, Types of Rolling Mills, Forces and Geometrical Relationships in Rolling, Calculation of Rolling Load, Roll Pass Design, and Defects in Rolled Products.	07
3.	Forging: Introduction and Classification, operation and principle of Forging Processes and Equipment, Methods of forging, Open and Close Die Forging Processes, Defects, Structure and Properties of Forged Products. Force Analysis in forging.	07
4.	Extrusion: Introduction and Classification, Extrusion Equipment, Forces in extrusion, Analysis of Extrusion Process, Extrusion of components including Seamless Pipes and Tubes. Extrusion of pipes by cold working,	06
5.	Drawing: Introduction and Classification, Wire Drawing, Rod Drawing, Tube Drawing, Deep Drawing, Analysis of Wire Drawing Process and Load Calculations.	06
6.	Sheet Metal Forming: Principle, process parameters, equipment and application of the following processes: spinning, stretch forming, plate, V and edge bending, Curling, Ironing, Roll Bending, Metal Spinning. Press brake forming, explosive forming, Hydro forming, electro hydraulic forming, and magnetic pulse forming. High Velocity forming of metals and High energy Rate forming	06

Assessment:**Internal Assessment for 20 marks:****Consisting Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books: -

1. Lin D Balint M Pietrzyk, Microstructure Evolution in Metal Forming Processes 1st Edition
2. Amitabha Ghosh and Asok Kumar Mallick, Manufacturing Science, Affiliated East-West Press
3. Christian Brecher and Ozdemir , Advances in Production Technology, Springer Publications
4. P.C.Sharma , A Text Book on Production Engineering, S.Chand Publications
5. P. N. Rao, “Manufacturing Technology”, Tata McGraw Hill
6. Aviter, “Fundamental of Metal Working”, McGraw Hill Publisher
7. Dieter, “Mechanical Metallurgy”

Links for online NPTEL/SWAYAM courses:

<https://nptel.ac.in/courses/112/107/112107250/> - Principles of Metal Forming Technology, IIT Roorkee

<https://nptel.ac.in/courses/112/106/112106153/> - Forming, IIT Madras

Course Code	Course Name	Credits
MEL601	Machine Design	01

Objectives:

1. To study the basic of modelling software, part design and assembly making.
2. To familiarize with use of design data books & various codes of practice.
3. Based on design calculation preparation of working drawings of actual design model.

Outcomes: Learner will be able to...

1. Design shaft under various conditions
2. Design Knuckle Joint / cotter joint
3. Design Screw Jack
4. Design Flexible flange couplings/ Leaf spring
5. Convert design dimensions into working/manufacturing drawing
6. Use design data book/standard codes to standardise the designed dimensions.

Term Work:

a) Term work - Shall consist of (minimum 3) design exercises from the list which may include computer aided drawing on A3 size sheets.

- 1) Knuckle Joint / cotter joint
- 2) Couplings
- 3) Screw Jack
- 4) Leaf springs

Software Analysis of any one component from the above list

b) Assignments:

Design exercises in the form of design calculations with sketches and/ or drawings on following machine elements.

- 1) Bolted and welded joints
- 2) Bearings.
- 3) Shaft design (solid and hollow shaft)
- 4) Flywheel and Belts.

The distribution of marks for term work shall be as follows:

Assignments, Exercises& Drawing sheets: 15 Marks

Course Project: 05 Marks (Minimum five components)

Attendance: 05 Marks

End Semester Practical/Oral examination:

1. Each student will be given a small task of design, based on syllabus, which will be assessed by pair of examiners during the oral examination.

2. Distribution of marks for practical-oral examination shall be as follows:

Design Task: 15 marks

Oral: 10 marks

3. Evaluation of practical/oral examination to be done based on the performance of design task.

4. Students work along with evaluation report to be preserved till the next examination.

Text/Reference Books

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication
3. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
4. Machine Design by Pandya & Shah, Charotar Publishing
5. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
6. Recommended Data Books - PSG
7. Machine Design by Reshetov, Mir Publication
8. Machine Design by Black Adams, McGraw Hill
9. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
10. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas& Co
11. Design of Machine Elements by V.M.Faires
12. Design of Machine Elements by Spotts.

Course Code	Course Name	Credits
MEL602	Turbo Machinery	01

Objectives

1. To familiarize with boilers, boiler mountings and accessories using models/cut sections.
2. To familiarize with hydraulic energy conversion devices.
3. To familiarize with thermal energy conversion devices.

Outcomes: Learner will be able to...

1. Differentiate boiler, boiler mountings and accessories
2. Conduct a trial on reciprocating compressor / centrifugal compressor.
3. Conduct a trial on impulse turbine and analyze its performance
4. Conduct a trial on reaction turbine and analyze its performance
5. Conduct a trial on Centrifugal pump and analyze its performance
6. Conduct a trial on Reciprocating pump and analyze its performance
7. Conduct a trial on gear pump

List of Experiments

Group-A (conduct any 7 including S.N.10)

1. Demonstration / e-learning of Boiler, Boiler mountings and accessories
2. Impact of jet
3. Trial on Impulse turbine (Pelton Wheel Turbine)
4. Trial on Reaction turbine (Francis Turbine)
5. Trial on Reaction turbine (Kaplan Turbine)
6. Trial on centrifugal pump (Single stage/Multistage)
7. Trial on reciprocating pump.
8. Trial on reciprocating / centrifugal air compressor
9. Trial on gear pump
10. Industrial visit to a power plant (compulsory)

Group –B (conduct any 3)

1. Measurement of Hydrostatic Pressures
2. Verification of Archimedes' Principle
3. Calibration of Venturimeter/ Orifice meter/Nozzle/ Pitot tube
4. Determination the friction factor in Pipes
5. Determination of major and minor losses in Pipe systems
6. Verification of Bernoulli's Equation
7. Calculation of Lift and Drag over an aerofoil

Assessment:**Term Work**

Term work shall consist of all the experiments from the list, 3 assignments containing numerical based on Centrifugal Pump, Reciprocating Pump and centrifugal compressor and a visit report.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments): 10 marks
- Assignments: 05 marks
- Visit report: 05 Marks
- Attendance: 05 marks

Virtual Labs

<http://fm-nitk.vlabs.ac.in/#> - Fluid Mechanics Lab, NITK Surathkal

<https://fmc-nitk.vlabs.ac.in/fluid-machinery/> - Fluid Machinery Lab, NITK Surathkal

Course Code	Course Name	Credits
MEL603	Heating, Ventilation, Air Conditioning and Refrigeration	01

Objectives:

1. To study working and operating principle of vapour Compression and vapour absorption system.
2. To study Controls and Components of refrigeration and Airconditioning system.
3. To design air conditioning systems using cooling load calculation.

Outcomes: Learner will be able to...

1. **Aware** of the roles and ethics of HVAC &R engineers in related industries.
2. **Present** the impact of professional engineering solutions in societal and environmental contexts.
3. performance of HVAC &R systems **Evaluate**
4. **Develop** awareness of the engineering and technological aspects in the HVAC &R industries.
5. **Communicate** effectively through the preparation of report and practical presentation.
6. **Analyse** design aspects of HVAC&R in various applications.

A -Part

List of Experiments

1. Study and performance on simple vapour compression test rig .
2. Study and performance of .heat pump test rig
3. Trial on Vapour absorption refrigeration test rig.
4. Perform humidification and dehumidification air conditioning process on air .conditioning test rig
5. Study and performance of cooling tower based on the cooling load and approach to wet bulb temperature.
6. Study and performance of refrigeration cycle on Ice plant.
7. Performance analysis on water cooler system .
8. Cooling capacity analysis of the desert cooler.
9. Steady state Simulation of VCR system with developed code or any analytical software.
10. Calculate cooling load of a confined space.

Part -B

/Case studies through Seminar Poster presentation on

1. Chiller unit
2. Building Management system(Introduction)
3. Effect on Ozone depletion andGlobal warming,
4. Alternative Refrigerants.
5. Refrigerant Different Protocols used in
6. Variable refrigerant flow technology & its smart control

Term Work

Term work shall consist of

1. Minimumsix experiments
2. Industrial visit on any HVAC &R plant
3. Case study report

Distribution:of Term work marks as follow

1. Experiments : 10 marks
2. Case study :5 marks
3. Industrial Visit Report : 5 Marks
4. Attendance (Theory + Practical) : 5 marks

End Semester Practical/Oral examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Practical examination (in a group of not more than 5 students) duration is 2 hours
3. Distribution of marks for practical/viva examination shall be as follows:
 - a. Practical performance**15** marks
 - b. Oral**10** marks
4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
5. .Evaluation of oral examination to be done based on the entire syllabus
6. Students work along with evaluation report to be preserved till the next examination

Virtual Labs

http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/refrigeration/index.php - Refrigeration and Air Conditioning Virtual Lab, IIT Bombay

Course Code	Course Name	Credits
MESBL601	Measurements and Automation	02

Objectives:

1. To study fundamentals of inspection methods and systems.
2. To study working of mechanical measurement system.
3. To familiarise with different types of control systems.
4. To study different hydraulic and pneumatic systems.
5. To study various design principles of robotics through kinematic analysis, workspace analysis and trajectory planning.

Outcomes: Learner will be able to...

1. Apply inspection gauge to check or measure surface parameters.
2. Measure surface parameters using precision measurement tools and equipment.
3. Measure different mechanical parameters by using sensors.
4. Analyse the response of a control systems.
5. Demonstrate use of automated controls using pneumatic and hydraulic systems.
6. Implement program on PLC system and demonstrate its application

The laboratory experiments should be based on the following:

Group A (Metrology):

1. Experiments on linear and angular measurement using Vernier calliper, micrometer and Bevel protractor.
2. Experiments on surface measurement by using Surface roughness tester.
3. Experiments on measurement of gear parameters using Gear tooth Vernier calliper / Parkinson gear tester.
4. Experiments on screw thread measurement using screw thread micrometer, Floating carriage micrometer / bench micrometer.
5. Experiments on linear / angular measurements of screw / gear /single point tool using Optical profile projector or Tool maker's microscope.
6. Experiment using Mechanical / Pneumatic type Comparator.
7. Experiments on flatness measurement by Autocollimator / Interferometry method

Group B (Mechanical Measurement):

1. Experiments on measurement of displacement by sensors like LVDT, Potentiometers etc.
2. Experiments on measurement of pressure by gauges or sensors like vacuum Gauges, pressure gauge, piezoelectric sensors, strain gauge sensors etc.
3. Experiments on measurement of vibration by accelerometers or NI.
4. Experiments on feedback control systems and servomechanisms
5. Experiment on frequency response system identification / transient state response of a control system.
6. Experiment on design of PID controller for a system or simulate and tune a PID controller using lab view.

Group C (Automation):

1. Experiment on trainer kit (Any one)

a) Designing sequential operation for two cylinders using electro-hydraulic circuits.

or

b) Designing sequential operation for two cylinders using electro- pneumatic circuits.

2. Experiment on simulation using software like Festo, AutoSim etc.

a) Simulation of basic pneumatic and electro-pneumatic circuits.

or

b) Simulation of hydraulic and electro-hydraulic circuits.

3. Experiments on Ladder programming

a) Experiments on Ladder programming on PLC for simple ON OFF control, timers, counter, two motor system, simple control applications with logic/ timers/counters.

or

b) Experiments on Ladder programming for Mechatronics system (e.g. bottle filling plant, control of electro-pneumatic or electro-hydraulic systems).

4. Experiments on Robotics

a) Demonstration and study of functions of components of robotics arm.

or

b) Visualization of DH (Denavit–Hartenberg) parameters in Roboanalyzer (*Roboanalyzer is free software developed by IIT Delhi, available on www.roboanalyzer.com).

Term Work

Term work shall consist of minimum Nine Experiments. Three from each group mentioned above. There will be no theoretical assignment for the lab course. The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 20 marks

Attendance: : 05 marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical and viva based on contents.

2. Practical examination (in a group of not more than 4 students) duration is 2 hours

3. Distribution of marks for practical/viva examination shall be as follows:

Practical performance: 15 marks

Oral: 10 marks

4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination.

5. Students work along with evaluation report to be preserved till the next examination.

Virtual Labs

<http://ial-coep.vlabs.ac.in/> - Industrial Automation Laboratory, COEP

Course code	Course Name	Credits
MEPBL601	Mini Project - 2B	02

Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to...

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.

- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
 - Marks awarded by guide/supervisor based on log book : 10
 - Marks awarded by review committee : 10
 - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
 - First shall be for finalisation of problem
 - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
 - First review is based on readiness of building working prototype to be conducted.
 - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
 - Identification of need/problem
 - Proposed final solution
 - Procurement of components/systems
 - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
 - First shall be for finalisation of problem and proposed solution
 - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
 2. Clarity of Problem definition based on need.
 3. Innovativeness in solutions
 4. Feasibility of proposed problem solutions and selection of best solution
 5. Cost effectiveness
 6. Societal impact
 7. Innovativeness
 8. Cost effectiveness and Societal impact
 9. Full functioning of working model as per stated requirements
 10. Effective use of skill sets
 11. Effective use of standard engineering norms
 12. Contribution of an individual's as member or leader
 13. Clarity in written and oral communication
- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
 - In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication