

# **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

<b>Title of the Course</b>	: Final Year in Bachelor of Civil Engineering
<b>Eligibility for Admission</b>	: After Passing First Year Engineering as per the Ordinance 0.6242
<b>Passing Marks</b>	: 40%
<b>Ordinances / Regulations (if any)</b>	: Ordinance 0.6242
<b>No. of Years / Semesters</b>	: 8 semesters
<b>Level</b>	: Under Graduation
<b>Pattern</b>	: Semester
<b>Status</b>	: New
<b>To be implemented from Academic Year</b>	: With effect from Academic Year: 2022-2023

**Dr. S. K. Ukarande**

Associate Dean  
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## **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.

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## **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.

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## **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.

<b>Board of Studies in Civil Engineering University of Mumbai</b>			
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 <sup>\$</sup>	-	-	1.5	-	1.5
<b>Total</b>		<b>15</b>	<b>14</b>	<b>1</b>	<b>15</b>	<b>7</b>	<b>1</b>	<b>23</b>

### 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
<b>Total</b>		<b>100</b>			<b>400</b>	<b>-</b>	<b>225</b>	<b>100</b>	<b>825</b>

**\$ 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 <sup>\$</sup>	-	-	1.5	-	1.5
<b>Total</b>		<b>16</b>	<b>14</b>	<b>01</b>	<b>16</b>	<b>07</b>	<b>01</b>	<b>24</b>

<b>Examination Scheme</b>									
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
<b>Total</b>		<b>100</b>			<b>400</b>	<b>-</b>	<b>225</b>	<b>125</b>	<b>850</b>

**\$ 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			
		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 <sup>\$</sup>	-	-	02	-	02
<b>Total</b>		<b>16</b>	<b>16</b>	<b>-</b>	<b>16</b>	<b>08</b>	<b>-</b>	<b>24</b>

<b>Examination Scheme</b>									
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
<b>Total</b>		<b>100</b>			<b>400</b>	<b>-</b>	<b>150</b>	<b>150</b>	<b>800</b>

\* 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**

<b>Sr. No.</b>	<b>Course Code CEDLO501X</b>	<b>Department Level Optional Course – 1</b>
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 <sup>\$</sup>	-	-	1.5	-	1.5
<b>Total</b>		<b>16</b>	<b>14</b>	<b>-</b>	<b>16</b>	<b>07</b>	<b>-</b>	<b>23</b>

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
<b>Total</b>		<b>100</b>			<b>400</b>	<b>-</b>	<b>150</b>	<b>150</b>	<b>800</b>

**\$ 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**

<b>Sr. No.</b>	<b>Course Code CEDLO601X</b>	<b>Department Level Optional Course – 2</b>
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
<b>Total</b>		<b>15</b>	<b>10</b>	<b>-</b>	<b>15</b>	<b>05</b>	<b>-</b>	<b>20</b>

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
<b>Total</b>		<b>100</b>			<b>400</b>	<b>-</b>	<b>75</b>	<b>75</b>	<b>650</b>

\* 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 Course – II	03	-	-	03	-	-	03
CEL801	Construction Management	-	02	-	-	01	-	01
CEP801	Major Project – Part II	-	12 <sup>\$</sup>	-	-	06	-	06
<b>Total</b>		<b>12</b>	<b>14</b>	<b>-</b>	<b>12</b>	<b>07</b>	<b>-</b>	<b>19</b>

<b>Examination Scheme</b>									
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
<b>Total</b>		<b>80</b>			<b>320</b>	<b>-</b>	<b>75</b>	<b>125</b>	<b>600</b>

**\$ : 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 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	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



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## 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
<b>I</b>	<b>Comprehensive Design of Building</b>		<b>11</b>
	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).	
<b>II</b>	<b>Design of Retaining Wall</b>		<b>06</b>
	2.1	Design of Cantilever retaining wall	
	2.2	Design of Counterfort retaining wall	
<b>III</b>	<b>Design of Water Tank</b>		<b>07</b>
	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.	
<b>IV</b>	<b>Introduction to Structural Dynamics</b>		<b>06</b>
	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.	
<b>V</b>	<b>Earthquake Resistant Design of Structures</b>		<b>06</b>
	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.	
<b>VI</b>	<b>Introduction to Pre-stressed Concrete</b>		<b>03</b>
	6.1	Prestressed Concrete: basic principles of prestressed concrete, materials used, systems of prestressing.	
	6.2	Losses in prestress.	
<b>Total</b>			<b>39</b>

## 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.

<b>Detailed Syllabus</b>			
<b>Module</b>	<b>Sub-Modules/ Contents</b>		<b>Hrs.</b>
<b>I.</b>	<b>Introduction</b>		<b>03</b>
	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	
<b>II.</b>	<b>Specifications &amp; Rate Analysis</b>		<b>06</b>
	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.	
<b>III.</b>	<b>Estimates</b>		<b>12</b>
	3.1	<b>Approximate Estimate</b> 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.	
	3.2	<b>Detailed Estimate</b> 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.	
<b>IV.</b>	<b>Estimation of Earthwork for Roads &amp; Canals</b>		<b>04</b>
	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.	
<b>V.</b>	<b>Tenders &amp; Contracts</b>		<b>06</b>
	5.1	<b>Tenders</b> 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	<b>Contracts</b> Definition, basic forms such as Valid, void & voidable contract. General types of contracts with their suitability, conditions of contract	

		Valuation	
VI.	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	08
	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.  
To make the candidate able to understand and implement the guidelines of Indian Standard code for analysis and design sections using limit state philosophy.

3

Detailed Syllabus

Module	Course Module / Contents		Periods
I	<b>Introduction of Pre-stressed Concrete</b>		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	<b>Analysis of Pre-stressed Concrete Beams</b>		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	<b>Losses in Prestress</b>		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	<b>Analysis of Pre-stressed Concrete Beams in Limit State of Serviceability Deflection</b>		04
	4.1	Deflection at transfer, short time and longtime deflection of uncracked beams, permissible limits	
V	<b>Analysis and Design of Pre-stressed Concrete Beams in Limit State of Collapse</b>		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	<b>Design of Pre-stressed Concrete Beams in Limit State of Serviceability, Maximum Compression and Cracking</b>		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	Duration of	TW	PR	OR	
Test 1	Test 2	Average	Exam	End Sem Exam				
20	20	20	80	3 hrs	-	-	-	100

### Rationale

This subject 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
	<b>1.1 Introduction:</b> Hydrological cycle, scope of hydrology, water budget equation, data sources.	

I	<p><b>1.2 Precipitation:</b> 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.</p>	8
II	<p><b>2.1 Abstractions from Precipitation:</b> Evaporation and transpiration, evapo-transpiration, interception, depression storage, infiltration and infiltration indices, determination of water losses.</p>	6
	<p><b>2.2 Stream Flow Measurement:</b> 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.</p>	
III	<p><b>3.1 Runoff:</b> Catchment, watershed and drainage basins, Factors affecting runoff, rainfall-runoff relationship, runoff estimation, droughts</p>	6
IV	<p><b>4.1 Hydrograph Analysis:</b> Characteristics, base flow separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, Instantaneous unit hydrograph.</p>	7
V	<p><b>5.1 Floods:</b> 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.</p>	6
VI	<p><b>6.1 Ground Water Hydrology:</b> 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.</p>	6
<b>Total</b>		<b>39</b>

<b>Contribution to Outcomes</b>
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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

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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
<b>I.</b>	<b>Construction Projects and Report Preparation</b>		<b>03</b>
	1.1	Classification of construction projects. Project Formulation and phases involved in it.	
	1.2	Feasibility studies, SWOT analysis. Preparation of Project report.	
<b>II.</b>	<b>Project Appraisal</b>		<b>06</b>
	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.	
<b>III.</b>	<b>Market Appraisal</b>		<b>09</b>
	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.	
<b>IV.</b>	<b>Technical and Managerial Appraisal</b>		<b>06</b>
	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.	
<b>V.</b>	<b>Financial analysis and Economic Appraisal</b>		<b>09</b>
	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.	
<b>VI.</b>	<b>Project Financing and Implementation</b>		<b>06</b>
	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.	
<b>Total</b>			<b>39</b>

## 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
<b>CEDLO 7014</b>	<b>Department Level Optional Course 3: Analysis of Offshore Structures</b>	<b>03</b>

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.
<b>I</b>	<b>Types of offshore structures</b>	<b>05</b>
	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.	
<b>II</b>	<b>Materials and their behaviour</b>	<b>06</b>
	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.	
<b>III</b>	<b>Analysis of offshore structures</b>	<b>06</b>
	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.	
<b>IV</b>	<b>Estimation of wave forces</b>	<b>06</b>
	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.	
<b>V</b>	<b>Vibrations</b>	<b>10</b>
	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	
<b>VI</b>	<b>Corrosion and allowances</b>	<b>06</b>
	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	
<b>Total</b>		<b>39</b>

## 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 1 GB, 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, 1<sup>st</sup> 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	<b>Sub Structure Construction</b>		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	<b>Super Structure Construction for building</b>		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	<b>Construction of Special Structures</b>		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	<b>Advancement in Construction techniques</b>		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	<b>Dredging</b>		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	<b>Rehabilitation and Strengthening Techniques</b>		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. Bhavkatti (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, Gyrotory 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 (10<sup>th</sup> 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 (3<sup>rd</sup> 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.

Draft Copy

## 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	<b>Estimation of Stresses in Soils</b>		04
	1.1	Boussinesque and Westergaard's theories	
	1.2	Newmark Chart	
	1.3	Practical applications.	
II	<b>Shallow Foundation</b>		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	<b>Pile Foundation</b>		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	<b>Floating Foundation and Well Foundation</b>		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	<b>Sheet piles and Braced cuts</b>		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	<b>Machine Foundations</b>		08
	6.1	Introduction, Dynamic soil properties as per IS 5249	
	6.2	Types of machine vibrations	
	6.3	Basic principles of machines foundation	
<b>Total</b>			<b>39</b>

## 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
<b>CEDLO7022</b>	<b>Department Optional Course-4 Solid and Hazardous Waste Management</b>	<b>03</b>

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.	--	--	--	

## 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	<b>Municipal Solid Waste Management</b>		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	<b>Waste Segregation, Storage, Collection and Transport</b>		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	<b>Waste processing techniques and Energy Recovery</b>		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	<b>Landfills for Disposal of Waste</b>		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	<b>Hazardous Waste Management</b>		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	<b>Assorted Solid Wastes</b>		
	6.1	<p><b>Biomedical waste</b> Need for Biomedical Waste Management, Sources, Classification, Storage and Segregation- Color coding, Collection and Transportation, Treatment and Disposal. Latest Biomedical waste management rules.</p> <p><b>Electronic Waste</b> Types, Component separation, Collection, Recycling and Recovery, E-waste management techniques and Latest E- waste management rules</p>	07
	6.2	<p><b>Plastic Waste</b> Problems related to plastic wastes, Plastic waste management- Recycling &amp; recovery, Energy production, Plastic waste management- Rules and Regulation</p> <p><b>Construction and Demolition waste</b> Composition, Recycling and reduction, Proper Management</p>	

### 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: Tchobanoglous, 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
<b>I</b>	<p><b>Introduction</b></p> <p>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.)</p> <p><b>Note:</b> Refer IS 13094 (1992): “Selection of ground improvement techniques for foundation in weak soils – Guidelines”</p>	<b>07</b>
<b>II</b>	<p><b>Compaction and Consolidation</b></p> <p>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</p>	<b>07</b>
<b>III</b>	<p><b>Stabilization of Soil</b></p> <p>Methods of stabilization; mechanical stabilization; lime, cement, fly-ash, bitumen, chemicals and polymer stabilization; Electrokinetic stabilization</p>	<b>05</b>

<p><b>IV</b></p>	<p><b>Grouting</b></p> <p>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.</p> <p><b>Note:</b> Refer IS 14343:1996 “Choice of Grouting Materials for Alluvial Grouting – Guidelines”</p>	<p><b>06</b></p>
<p><b>V</b></p>	<p><b>Stone Columns</b></p> <p>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</p> <p><b>Note:</b> Refer IS 15284-1 (2003): “Design and construction for ground improvement - Guidelines, Part 1: Stone columns”</p>	<p><b>07</b></p>
<p><b>VI</b></p>	<p><b>Reinforced Earth and Anchors</b></p> <p>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.</p>	<p><b>07</b></p>
<p><b>Total</b></p>		<p><b>39</b></p>

<b>Contribution to Outcome</b>
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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”, 4<sup>th</sup> 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	--	--	--	

### 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 CO<sub>2</sub>. 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	<b>Introduction</b>		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	<b>Site Selection, Planning and Design</b>		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	<b>Water Conservation and Energy Efficiency</b>		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	<b>Green building materials and indoor environmental quality</b>		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 <sub>2</sub> 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	
<b>V</b>	<b>Green building rating systems</b>		<b>4</b>
	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	
<b>VI</b>	<b>Green audit and green retrofitting</b>		<b>4</b>
	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. Muruges (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)

Draft Copy



## 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	-	-	20	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	<b>Introduction to Legal Aspects in Construction Industry</b>		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	<b>Contracting in Construction</b>		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	<b>Tendering in Construction</b>		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	<b>Arbitration and Dispute Resolution</b>		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	<b>Health, Safety and Labour Laws</b>		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	<b>Environmental Protection and Ethics</b>		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	<b>Department Level Optional Course-4: Environmental Impact Assessment</b>	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	<b>Environmental impact assessment</b>	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	<b>Environmental assessment process</b> 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	<b>Environmental Impact Assessment Process</b> Basic concept behind EIS, Stages in EIS production: Screening, scoping, prediction, evaluation, reducing impact, monitoring, conclusions, typical EIS outline	5
IV	<b>Rapid EIA</b> Rapid EIA, when it is carried out, advantages and disadvantages	6
V	<b>Environmental Auditing</b> Definition, aims and objectives, audit principles, incentives to undertake audit, partial environmental audits, stages of implementing environmental audits, scope of audit	7
VI	<b>Provisions of various environmental acts of India</b> 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.

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

**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
<b>I</b>	<p><b>Introduction to Steel Structure and Moment Resistant Beam End Connections:</b></p> <p>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.</p> <p>Design of moment resistant bolted and welded beam end connections by limit state method</p>	<b>07</b>
<b>II</b>	<p><b>Gantry Girder :</b></p> <p>Loads acting on gantry girder, Analysis of gantry girder, design of gantry girder by limit state method.</p>	<b>06</b>
<b>III</b>	<p><b>Round Tubular Structural Members :</b></p> <p>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</p>	<b>06</b>
<b>IV</b>	<p><b>Elevated Steel Tanks and Stacks :</b></p> <p>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,</p>	<b>08</b>
<b>V</b>	<p><b>Lattice Tower:</b></p> <p>Different configuration of lattice towers, loads acting on lattice towers, Analysis of lattice tower,</p>	<b>06</b>
<b>VI</b>	<p><b>Steel Chimney :</b></p> <p>Forces acting on chimney, design of self supporting welded and bolted chimney and components including design of foundation.</p>	<b>06</b>

### 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

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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	<p><b>Introduction to Product Life-cycle Management (PLM):</b> Product Life-cycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance &amp; Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications</p> <p><b>PLM Strategies:</b> Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM</p>	10
II	<p><b>Product Design:</b> 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</p>	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	
<b>III</b>	<b>Product Data Management (PDM):</b> 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
<b>IV</b>	<b>Virtual Product Development Tools:</b> 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
<b>V</b>	<b>Integration of Environmental Aspects in Product Design:</b> 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
<b>VI</b>	<b>Life Cycle Assessment and Life Cycle Cost Analysis:</b> 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	<p><b>Probability theory:</b> Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.</p> <p><b>Probability Distributions:</b> Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.</p> <p><b>Measures of Dispersion:</b> Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.</p>	08
II	<p><b>Reliability Concepts:</b> Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.</p> <p><b>Failure Data Analysis:</b> Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.</p> <p><b>Reliability Hazard Models:</b> Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.</p>	08
III	<p><b>System Reliability:</b> System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.</p>	05
IV	<p><b>Reliability Improvement:</b> Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.</p> <p>System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.</p>	08

V	<p><b>Maintainability and Availability:</b> System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement.</p> <p>Availability – qualitative aspects.</p>	05
VI	<p><b>Failure Mode, Effects and Criticality Analysis:</b> 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</p>	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.	--	--	--	

Objectives:
<ul style="list-style-type: none"> <li>• The course is blend of Management and Technical field.</li> <li>• Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built</li> <li>• Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage</li> <li>• Identify the basic steps in systems development</li> </ul>

Module	Detailed Contents	Hrs
I	<b>Introduction To Information Systems (IS):</b> Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
II	<b>Data and Knowledge Management:</b> 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	<b>Ethical issues and Privacy:</b> Information Security. Threat to IS, and Security Controls	7
IV	<b>Social Computing (SC):</b> 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	<b>Computer Networks Wired and Wireless technology,</b> Pervasive computing, Cloud computing model.	6
VI	<b>Information System within Organization:</b> Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. <b>Acquiring Information Systems and Applications:</b> 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, 10<sup>th</sup> 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	<b>Introduction</b> 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	<b>Fitting Regression Models</b> 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	<b>Two-Level Factorial Designs</b> 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	<b>Two-Level Fractional Factorial Designs</b>	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	<b>Response Surface Methods and Designs</b> 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	<b>Taguchi Approach</b> 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:

1. Raymond H. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3<sup>rd</sup> 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, 2<sup>nd</sup> 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

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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	80	03 Hrs.	--	--	--	100

Objectives:
<ul style="list-style-type: none"> <li>Formulate a real-world problem as a mathematical programming model.</li> <li>Understand the mathematical tools that are needed to solve optimization problems.</li> <li>Use mathematical software to solve the proposed models.</li> </ul>

Module	Detailed Contents	Hrs
I	<p><b>Introduction to Operations Research:</b> Introduction, , Structure of the Mathematical Model, Limitations of Operations Research</p> <p><b>Linear Programming:</b> 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, <b>Duality</b>, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</p> <p><b>Transportation Problem:</b> 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.</p> <p><b>Assignment Problem:</b> 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</p>	14

	<b>Integer Programming Problem:</b> Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
<b>II</b>	<b>Queuing models:</b> queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
<b>III</b>	<b>Simulation:</b> 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
<b>IV</b>	<b>Dynamic programming.</b> Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
<b>V</b>	<b>Game Theory.</b> 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
<b>VI</b>	<b>Inventory Models:</b> 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 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.

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.	--	--	--	

Objectives:
<ul style="list-style-type: none"> <li>To understand and identify different types cyber crime and cyber law</li> <li>To recognized Indian IT Act 2008 and its latest amendments</li> <li>To learn various types of security standards compliances</li> </ul>

Module	Detailed Contents	Hrs
I	<b>Introduction to Cyber crime:</b> 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	<b>Cyber offenses &amp; Cyber crime:</b> 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	<b>Tools and Methods Used in Cyber line</b> 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	<b>The Concept of Cyberspace</b> 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	<b>Indian IT Act.</b> Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
VI	<b>Information Security Standard compliances</b> 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	80	03 Hrs.	--	--	--	100

#### 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	<b>Introduction</b> 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	<b>Natural Disaster and Manmade disasters:</b> 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	<b>Disaster Management, Policy and Administration</b> 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	<p><b>Institutional Framework for Disaster Management in India:</b></p> <p>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.</p> <p>4.2 Use of Internet and software for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.</p>	06
V	<p><b>Financing Relief Measures:</b></p> <p>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.</p> <p>5.2 International relief aid agencies and their role in extreme events.</p>	09
VI	<p><b>Preventive and Mitigation Measures:</b></p> <p>6.1 Pre-disaster, during disaster and post-disaster measures in some events in general</p> <p>6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication</p> <p>6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans.</p> <p>6.4 Do's and Don'ts in case of disasters and effective implementation of relief aids.</p>	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.	--	--	--	100

#### 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	<b>Energy Scenario:</b> 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	<b>Energy Audit Principles:</b> 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	<b>Energy Management and Energy Conservation in Electrical System:</b> Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings.	10

	<b>Energy efficiency measures in lighting system, Lighting control:</b> 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	<b>Energy Management and Energy Conservation in Thermal Systems:</b> 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	<b>Energy Performance Assessment:</b> 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	<b>Energy conservation in Buildings:</b> 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](http://www.energymanagertraining.com)
9. [www.bee-india.nic.in](http://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 73<sup>rd</sup> 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 (73<sup>rd</sup> 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.

<b>List of Tutorials and Assignments</b>		
<b>Week (Activity)</b>	<b>Detailed Content</b>	<b>Hours</b>
1 <sup>st</sup> Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Drawing of structural plan on Sheet no. 1)	<b>02</b>
2 <sup>nd</sup> Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of Staircase)	<b>02</b>
3 <sup>rd</sup> 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)	<b>02</b>
4 <sup>th</sup> 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)	<b>02</b>
5 <sup>th</sup> Week (Tutorial)	Project – I – Design of G+3 RCC Framed Building. (Design of Columns and Detailing of reinforcement for columns on sheet no. 4)	<b>02</b>
6 <sup>th</sup> 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)	<b>02</b>
7 <sup>th</sup> Week (Assignment)	Assignment no. 1 Introduction to Structural Dynamics (Maximum 5 Questions)	<b>02</b>
8 <sup>th</sup> Week. (Assignment)	Assignment no. 2 Earthquake resistant design of structures (Maximum 5 Questions)	<b>02</b>
9 <sup>th</sup> Week (Tutorial)	Project – II – Design of Counterfort retaining wall Design of the elements of counterfort retaining wall using LSM	<b>02</b>
10 <sup>th</sup> Week (Tutorial)	Project – II – Design of Counterfort retaining wall (Detailing of reinforcement of counterfort retaining wall on sheet no. 6)	<b>02</b>
11 <sup>th</sup> Week (Assignment)	Assignment no. 3 Design of water tanks using WSM (Maximum 5 Questions)	<b>02</b>
12 <sup>th</sup> Week (Assignment)	Assignment no. 4 Introduction to prestressed concrete Maximum 5 Questions	<b>02</b>
13 <sup>th</sup> Week	Viva – Voce Examination	<b>02</b>

#### **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 <b>two</b> 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 advise 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

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# 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	<b>Introduction to Construction Management</b>	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	<b>Construction Projects:</b>		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	<b>Construction project planning &amp; Scheduling:</b>		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	<b>Resources Management &amp; Allocation :</b>		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	<b>Project Monitoring &amp; Cost Control :</b>		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	<b>Construction Safety, Quality Control &amp; Labour Acts:</b>		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	<b>Introduction of Bridge Engineering</b>		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	<b>IRC loads, their distribution and design of superstructure for roadway bridges using limit state method</b>		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	<b>IRS loads, analysis and design of steel lattice girder bridge for broad gauge railway</b>		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	<b>Substructure</b>		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	<b>Erection of girder and construction methods</b>		2
	5.1	Various methods of erection of bridge girders	
	5.2	Cantilever method of construction of bridge	
VI	<b>Inspection and repairs of bridges</b>		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	--	02	03	--	--	04

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**

<b>Module</b>	<b>Course Module / Contents</b>	<b>Periods</b>
<b>I</b>	<b>Reservoir Planning and Management:</b>	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.	
<b>II</b>	<b>Gravity Dams:</b>	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.	
<b>III</b>	<b>Arch and Buttress Dams:</b>	4
	Types of arch dams, forces acting on arch dam, design of arch dams, types of buttress dams.	
<b>IV</b>	<b>Earth and Rock Fill Dams:</b>	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.	
<b>V</b>	<b>Spillways and Flood Control Works:</b>	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.	
<b>VI</b>	<b>Miscellaneous Topics:</b>	
	Diversion head works-Component parts, functions, weirs and barrages, Bligh's Creep theory, Lane's weighed 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								
<p>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.</p> <p>Students will also learn procedures for recognizing hazards, CPR, site safety meetings and accident investigations.</p>								
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	<b>Construction Safety Management:</b>			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	<b>Safety in construction operations and emergency response</b>			06

	2.1	Safety on various construction sites viz. buildings, dams, Tunnels, bridges, roads	
	2.2	Safety at various stages of construction. CPR, site safety meetings	
	2.3	Prevention of accidents. Safety measures. (preferably, site visit shall be arranged to understand the actual safety measures undertaken on construction sites)	
III	<b>Safety in use of construction equipment</b>		07
	3.1	Safety while operating construction equipment. vehicles, cranes, hoists and lifts	
	3.2	Safety of scaffolding and working platforms	
	3.3	Safety while using electrical appliances and explosives used.	
IV	<b>Accident prevention mechanisms</b>		12
	4.1	Hazard Recognition, Evaluation, and Control.	
	4.2	Fall Hazards & Fall Arrest- Ladders, Stairs, & Scaffolds	
	4.3	Electrical Safety Guidelines & Lockout, Tag-out. Struck-By and Caught-in-Between Hazards	
	4.4	Personal Protective gear, first aid on construction sites	
	4.5	Job-Site Exposure Hazards, Occupational Hazards	
	4.6	Environmental Extremes - extreme hot and extreme cold weather hazards	
V	<b>Labor Laws and legal requirements</b>		04
	5.2	Study of various existing national and state laws for worker safety and well-being	
	5.2	Accident Analysis, computation of costs of accidents for various scenarios, Worker's compensation insurance	
VI	<b>Study of Safety Policies</b>		06
	6.1	Study of safety policies, methods, equipment and training provided on any ISO approved construction company. Safety Standards and codes	
	6.2	Safety in office, working on sites of high rise construction, prevention of workplace violence	
	6.3	Observance of safety week, zero accident period, awards to best employee (for safety adherence), reprimands to habitual defaulters, etc.	

Contribution to Outcome	
On completion of this course, the students will be able to:	
1	Apply safety mechanisms and concepts for improving overall safety of construction sites
2	Demonstrate the various safety requirements
3	Explain the various techniques to prevent accidents.
4	Examine construction safety management.
5	Implement safety policies, methods and training on construction sites.
6	Practice safety in construction operations.
<b>Internal Assessment</b>	<b>20 Marks</b>

Consisting 2 Compulsory Class Tests - 1 <sup>st</sup> test based on approximately 40% of contents and 2 <sup>nd</sup> test based on remaining contents (approximately 40% but excluding contents covered in Test I)	
<b>End Semester Examination</b>	<b>80 Marks</b>
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.
<b>Recommended Books:</b>	
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 <sup>th</sup> edition, ISBN-10 : 9386953293,ISBN-13 : 978-9386953292
9	Construction Safety Handbook - Davis V.S Thomasin K, Thomas Telford, London
<b>Reference Books:</b>	
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 <a href="http://www.osha.gov/readingroom.html">www.osha.gov/readingroom.html</a>

## 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	
VI	5.3	Joints and reinforcement requirement.	05
	Design of Overlay		
	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 10<sup>th</sup> Edition, 2014)
- 3 Principles, Practice and Design of Highway Engineering (Including Airport Pavements): *Sharma, S.K.*, S. Chand Technical Publications (3<sup>rd</sup> 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

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## Semester VIII

Course Code	Course Name	Credits
CEDLO8015	<b>Department Optional Course 5: Industrial Waste Treatment</b>	<b>03</b>

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	<b>Introduction to industrial waste and treatments:</b> 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	<b>Stream Protection Measures:</b> 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	<b>Waste minimization:</b>		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	<b>Waste-water treatments for industries</b>		06
	4.1	<b>Biological treatments:</b> 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	<b>Advanced treatments:</b> Need for advance technologies, Automated Chemostat Treatment (ACT) Soil Biotechnology (SBT) Reed Bed Technology (RBT) Ozonation	
V	<b>Industries and waste-water management:</b> Raw material, Manufacturing process and flow-sheets, sources of effluents, characteristics, ETP, byproduct recovery for following industries: <ul style="list-style-type: none"> <li>● Sugar</li> <li>● Distillery</li> <li>● Tannery</li> </ul>		10

	<ul style="list-style-type: none"> <li>● Dairy</li> <li>● Paper and Pulp</li> <li>● Metal Processing Industry (Electroplating)</li> </ul>		
VI	<b>Legal Aspects, Environment Management Tools and Common Treatment Facility for industries</b>		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.	

<b>Contribution to Outcome</b>
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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
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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
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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.



<b>Detailed Syllabus</b>		
<b>Module</b>	<b>Sub- Modules/Contents</b>	<b>Hrs</b>
<b>I.</b>	<b>Introduction to Soil Dynamics</b>	<b>04</b>
	<b>1.1</b> Introduction to vibration (simple harmonic motion), Types of waves <b>1.2</b> Introduction to the concept of degree of freedom <b>1.3</b> Introduction to dynamic soil properties (IS4249) <b>1.4</b> Scope and objective, Nature and types of dynamic loading, Importance of soil dynamics.	
<b>II.</b>	<b>Dynamic approach in different components</b>	<b>05</b>
	<b>2.1</b> Wave propagation in elastic rods, in an elastic finite medium and in semi-elastic half space <b>2.2</b> Wave generated by surface footing	
<b>III.</b>	<b>Liquefaction of Soil</b>	<b>08</b>
	<b>3.1</b> Introduction to liquefaction of soils and its basic terminologies, criterion and factors affecting liquefaction of soil. <b>3.2</b> Liquefaction studies in triaxial shear, field studies on liquefaction <b>3.3</b> Evaluation of liquefaction potential using analytical method and SPT.	
<b>IV.</b>	<b>Machine Foundation</b>	<b>06</b>
	<b>4.1</b> 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 <b>4.2</b> Practical design considerations and codal provisions.	
<b>V.</b>	<b>Dynamic behavior of Machine Foundation</b>	<b>05</b>
	<b>5.1</b> Mass of soil participating in vibration. <b>5.2</b> Vibration isolation and screening methods, improvement of distressed machine foundation.	
<b>VI.</b>	<b>Dynamic behavior of Retaining Wall</b>	<b>11</b>
	<b>6.1</b> 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. <b>6.2</b> 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.	
<b>Total teaching Hours</b>		<b>39</b>

<b>Course Outcome</b>
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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

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

## Detailed Syllabus

Module	Contents	Periods
<b>1</b>	<b>Introduction</b>	<b>03</b>
	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	
<b>2</b>	<b>Damage Assessment</b>	<b>08</b>
	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	
<b>3</b>	<b>Repair of Concrete Structures</b>	<b>06</b>
	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	
<b>4</b>	<b>Rehabilitation and Retrofitting Methods</b>	<b>10</b>
	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.	
<b>5</b>	<b>Repair of steel structures</b>		<b>06</b>
	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.	
<b>6</b>	<b>Seismic Retrofitting and Maintenance of Heritage Structures</b>		<b>06</b>
	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.	
<b>Total</b>			<b>39</b>

### 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	<b>Quality, Quantity of Water and Waste-water</b>	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	<b>Preliminary Treatment of Water and Waste-water</b>	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	<b>Primary Treatment of Water and Waste-water</b>	8
	<b>Sedimentation:</b> Significance, Types of sedimentation tanks, Zones of settling, Design parameters, Design of sedimentation tank, Tube settlers <b>Filtration:</b> Mechanisms of filtration, hydraulics of filtration, different types of filters, filter clogging, filter washing, Design criteria of Rapid sand filter	
IV	<b>Chemical units-Techniques:</b>	6
	Role of chemical unit processes in water and waste water treatment, <b>Coagulation:</b> Fundamentals, coagulant aids, polyelectrolytes, Design of flash mixer, power requirement <b>Flocculation:</b> Types of flocculation and flocculators, Design of flocculator, power requirement	
V	<b>Advanced Physico-chemical Processes:</b>	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	<b>Sludge De-watering and Disposal</b>	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	<b>Department Level Optional Course-5: Smart Building Materials</b>	<b>03</b>

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

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem	Duration of End	TW	PR	OR	
Test-I	Test-II	Average	Exam	Sem Exam				
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
<b>I</b>	<p><b>Introduction to Smart Building Materials &amp; Technology</b></p> <p>History, importance and need, merits and demerits of smart building materials. Smart Structure system, Components, Importance of smart structures.</p>	<b>02</b>
<b>II</b>	<p><b>Fundamentals of Smart Materials</b></p> <p>Types and characteristics of smart materials:-</p> <p><b>Property-changing materials:</b> Thermo-chromics, Photochromics, Mechanochromics, Chemochromics, Electrochromics, Liquid crystals, Suspended particle, Electrorheological, Magnetorheological</p> <p><b>Energy-exchanging materials:</b> Electroluminescents, Photoluminescents, Chemoluminescents, Thermoluminescents, Light-emitting diodes, Photovoltaics,</p> <p><b>Energy-exchanging (reversible) materials:</b> Piezoelectric, Pyroelectric, Thermoelectric, Electrorestrictive, Magnetorestrictive.</p> <p><b>Miscellaneous Materials:</b> 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.</p>	<b>09</b>
<b>III</b>	<p><b>Energy Efficient Materials, Durability and Technology</b></p> <p>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.</p> <p>Service life, Life cycle concept for structures and selection of materials for durability and sustainability. Use of Thermal and Sound Insulation systems and materials.</p>	<b>06</b>
<b>IV</b>	<p><b>Smart Structural Health Monitoring</b></p>	<b>09</b>

	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	<b>Smart Concrete:</b> 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	<b>Applications of Smart Materials and Technology:</b> 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	Duration of ESE	TW/TU	PR	OR	
IA-I	IA-II	Avg.						
20	20	20	80	3 Hr	--	--	--	100

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
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Module	Contents	Hrs
I	<b>Introduction to structural Dynamics- Definition of Basic Problem in Dynamics.</b> Static vs. Dynamic loads. Different types of dynamics loads	4
II	<b>Introduction to single Degree of freedom (SDOF) Systems.</b> 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

<b>III</b>	<b>Introduction to Distributed mass system.</b> Distributed mass system idealized as SDOF system, use of Rayleigh's method. Response of SDOF system subjected to ground motion	<b>4</b>
<b>IV</b>	<b>Lumped mass multi-degree of freedom (Two DOF) system, coupled and uncoupled system</b> 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	<b>9</b>
<b>V</b>	<b>Earthquake analysis – Introduction.</b> 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.	<b>8</b>
<b>VI</b>	<b>I.S code provisions for seismic analysis of buildings.</b> Approximate method of earthquake analysis– Seismic co-efficient method and its limitation. Introduction to time history analysis.	<b>6</b>

### 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*.

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## Semester VIII

Course Code	Course Name	Credits
CEDLO8026	<b>Department Level Optional Course 6: Ground water Engineering</b>	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
<b>I</b>	<b>Hydrogeological Parameters</b>		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	

<b>II</b>	<b>Well Hydraulics</b>		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	
<b>III</b>	<b>Groundwater Management</b>		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	
<b>IV</b>	<b>Groundwater Quality</b>		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	
<b>V</b>	<b>Groundwater Conservation</b>		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	
<b>VI</b>	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 Wter 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	<b>Project Management Foundation:</b> 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	<b>Initiating Projects:</b> 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	<b>Project Planning and Scheduling:</b> 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	<b>Planning Projects:</b> 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	<p><b>5.1 Executing Projects:</b> Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings.</p> <p><b>5.2 Monitoring and Controlling Projects:</b> Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.</p> <p><b>5.3 Project Contracting</b> Project procurement management, contracting and outsourcing,</p>	8
VI	<p><b>6.1 Project Leadership and Ethics:</b> Introduction to project leadership, ethics in projects. Multicultural and virtual projects.</p> <p><b>6.2 Closing the Project:</b> 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.</p>	6

<b>Outcomes</b>
<p>Students will be able to :</p> <ul style="list-style-type: none"> <li>• Apply selection criteria and select an appropriate project from different options.</li> <li>• Write work break down structure for a project and develop a schedule based on it.</li> <li>• Identify opportunities and threats to the project and decide an approach to deal with them strategically.</li> <li>• Use Earned value technique and determine &amp; predict status of the project.</li> <li>• Capture lessons learned during project phases and document them for future reference</li> </ul>

**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, 7<sup>th</sup>Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK<sup>®</sup> Guide), 5<sup>th</sup> 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, 9 th 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
<b>I</b>	<p><b>Overview of Indian Financial System:</b> Characteristics, Components and Functions of Financial System.</p> <p><b>Financial Instruments:</b> Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p><b>Financial Markets:</b> Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p><b>Financial Institutions:</b> Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	<b>06</b>
<b>II</b>	<p><b>Concepts of Returns and Risks:</b> 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.</p> <p><b>Time Value of Money:</b> 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.</p>	<b>06</b>
<b>III</b>	<p><b>Overview of Corporate Finance:</b> Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p><b>Financial Ratio Analysis:</b> 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;</p>	<b>09</b>

	Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
<b>IV</b>	<b>Capital Budgeting:</b> 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) <b>Working Capital Management:</b> 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.	<b>10</b>
<b>V</b>	<b>Sources of Finance:</b> Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. <b>Capital Structure:</b> 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	<b>05</b>
<b>VI</b>	<b>Dividend Policy:</b> 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, 13<sup>th</sup> Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10<sup>th</sup> Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9<sup>th</sup> Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.

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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
<b>I</b>	<b>Overview Of Entrepreneurship:</b> 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	<b>04</b>
<b>II</b>	<b>Business Plans And Importance Of Capital To Entrepreneurship:</b> 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 <b>Entrepreneurship And Business Development:</b> Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	<b>09</b>
<b>III</b>	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises.	<b>05</b>
<b>IV</b>	<b>Indian Environment for Entrepreneurship:</b> 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,	<b>08</b>

	National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
<b>V</b>	<b>Effective Management of Business:</b> 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	<b>08</b>
<b>VI</b>	<b>Achieving Success In The Small Business:</b> 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	<b>05</b>

### **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. MaddhurimaLall, ShikahSahai, 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](http://www.msme.gov.in)
12. [www.dcmesme.gov.in](http://www.dcmesme.gov.in)
13. [www.msmetraining.gov.in](http://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:
<ul style="list-style-type: none"> <li>To introduce the students with basic concepts, techniques and practices of the human resource management.</li> <li>To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.</li> <li>To familiarize the students about the latest developments, trends &amp; different aspects of HRM.</li> <li>To acquaint the student with the importance of inter-personal &amp; inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.</li> </ul>

Module	Detailed Contents	Hrs
I	<b>Introduction to HR</b> 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	<b>Organizational Behavior (OB)</b> 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	<b>Organizational Structure &amp; Design</b> 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.	
<b>IV</b>	<b>Human resource Planning</b> 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
<b>V</b>	<b>Emerging Trends in HR</b> 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
<b>VI</b>	<b>HR &amp; MIS</b> 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) <b>Strategic HRM</b> 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 <b>Labour Laws &amp; Industrial Relations</b> 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, 16<sup>th</sup> Ed, 2013
2. V S P Rao, Human Resource Management, 3<sup>rd</sup> Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6<sup>th</sup> edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15<sup>th</sup> Ed, 2015, Himalaya Publishing, 15<sup>th</sup>edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5<sup>th</sup> 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	80	03 Hrs.	--	--	--	100

Objectives:
<ul style="list-style-type: none"> <li>To understand professional ethics in business</li> <li>To recognized corporate social responsibility</li> </ul>

Module	Detailed Contents	Hrs
I	<b>Professional Ethics and Business:</b> 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	<b>Professional Ethics in the Marketplace:</b> Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy <b>Professional Ethics and the Environment:</b> Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
III	<b>Professional Ethics of Consumer Protection:</b> Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy <b>Professional Ethics of Job Discrimination:</b> Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
IV	<b>Introduction to Corporate Social Responsibility:</b> 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	<b>Corporate Social Responsibility:</b> 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	<b>Corporate Social Responsibility in Globalizing India:</b> 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					Term work / Practical / Oral			Total Marks
Theory			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Internal Assessment								
Test 1	Test 2	Average						
20	20	20	80	03 Hrs.	--	--	--	100

Objectives:
<ul style="list-style-type: none"> <li>To understand Research and Research Process</li> <li>To acquaint students with identifying problems for research and develop research strategies</li> <li>To familiarize students with the techniques of data collection, analysis of data and interpretation</li> </ul>

Module	Detailed Contents	Hrs
I	<b>Introduction and Basic Research Concepts</b> 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	<b>Types of Research</b> 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	<b>Research Design and Sample Design</b> 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	<b>Research Methodology</b> 4.1 Meaning of Research Methodology	08

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

#### 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, (2<sup>nd</sup>ed), Singapore, Pearson Education

Semester VIII		
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	<b>Introduction to Intellectual Property Rights (IPR):</b> Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. <b>Importance of IPR in Modern Global Economic Environment:</b> Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
II	<b>Enforcement of Intellectual Property Rights:</b> Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement <b>Indian Scenario of IPR:</b> 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	<b>Emerging Issues in IPR:</b> Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
IV	<b>Basics of Patents:</b> 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

<b>V</b>	<b>Patent Rules:</b> 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
<b>VI</b>	<b>Procedure for Filing a Patent (National and International):</b> 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 <b>Patent databases:</b> 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, 7<sup>th</sup> Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3<sup>rd</sup> 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

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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	<p><b>Introduction to Digital Business-</b> Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts</p> <p>ference between physical economy and digital economy,</p> <p><b>Drivers of digital business-</b> Big Data &amp; Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)</p> <p>Opportunities and Challenges in Digital Business,</p>	09
II	<p><b>Overview of E-Commerce</b></p> <p><b>E-Commerce-</b> Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement</p> <p>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</p> <p>Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing</p> <p>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</p>	06
III	<p><b>Digital Business Support services:</b> ERP as e –business backbone, knowledge Tope Apps, Information and referral system</p> <p><b>Application Development:</b> Building Digital business Applications and Infrastructure</p>	06
IV	<p><b>Managing E-Business-</b>Managing Knowledge, Management skills for e-business, Managing Risks in e –business</p> <p>Security Threats to e-business -Security Overview, Electronic Commerce</p>	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	<b>E-Business Strategy</b> -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	<b>Caterializing e-business: From Idea to Realization</b> -Business plan preparation <b>Case Studies and presentations</b>	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, 6<sup>th</sup> 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, 2<sup>nd</sup> 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 2<sup>nd</sup> 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, 3<sup>rd</sup> 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	<b>Assignment No. 1:</b> Principles, Functions, and contribution eminent personalities towards Management	02
2	<b>Assignment No.2:</b> Project classifications, Unique features of construction, Various agencies involved in construction industry	02
3	<b>Assignment No.3:</b> Bar Charts its limitations and its uses Numerical on development of networks and calculation of floats using CPM technique.	02
4	<b>Assignment No.4:</b> Assumption underlying PERT analysis time estimates, slack& its types, probability of completing the project.	02
5	<b>Assignment No.5:</b> Numerical on Resources Allocation Methods- Resource levelling and Smoothing	02
6	<b>Assignment No.6:</b> Procedure and Numerical on Time and cost optimization in construction projects - Compression & decompression of network.	02
7	<b>Assignment No.7:</b> Network Updating- Purpose and frequency of updating. Numerical on Project Updating	02
8	<b>Assignment No.8:</b> 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	150

### 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