AC-29/06/2021
Item No.-6.2

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Civil Engineering

Second Year with Effect from AY 2020-2021

Third Year with Effect from AY 2021-2022

Final Year with Effect from AY 2022-2023

(REV-2019 'C' Scheme) from Academic Year 2019-2020

Under

FACULTY OF SCIENCE & TECHNOLOGY

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

Syllabus for Approval

Title of the Course	**:**	Third Year in Bachelor of Civil Engineering
Eligibility for Admission	**:**	After Passing First Year Engineering as per the Ordinance 0.6242
Passing Marks	**:**	40%
Ordinances / Regulations (if any)	**:**	Ordinance 0.6242
No. of Years / Semesters	**:**	8 semesters
Level	**:**	Under Graduation
Pattern	**:**	Semester
Status	**:**	New
To be implemented from Academic Year	**:**	With effect from Academic Year: 2021-2022

Dr. S. K. Ukarande

Associate Dean
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Dr Anuradha Muzumdar

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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 Third Year of Engineering from the Academic year 2021-22. Subsequently this will be carried forward for Final Year Engineering in the academic years 2022-23.

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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.

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

Undergraduate Program Structure for Second year Civil Engineering
University of Mumbai
(With Effect from A.Y. **2020-2021**)
Semester – III

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

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

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

Undergraduate Program Structure for Second year Civil Engineering
University of Mumbai
(With Effect from A.Y. **2020-2021**)
Semester IV

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

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

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

Undergraduate Program Structure for Third year Civil Engineering
University of Mumbai
(With Effect from A.Y. **2021-2022**)
Semester - V

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

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC501	Theory of Reinforced Concrete Structures	20	20	20	80	03	-	-	100
CEC502	Applied Hydraulics	20	20	20	80	03	-	-	100
CEC503	Geotechnical Engineering-I	20	20	20	80	03	-	-	100
CEC504	Transportation Engineering	20	20	20	80	03	-	-	100
CEDLO501 X	Department Level Optional Course -1	20	20	20	80	03	-	-	100
CEL501	Theory of Reinforced Concrete Structures	-	-	-	-	-	25	25	50
CEL502	Applied Hydraulics	-	-	-	-	-	25	25	50
CEL503	Geotechnical Engineering-I	-	-	-	-	-	25	25	50
CEL504	Transportation Engineering	-	-	-	-	-	25	25	50
CEL505	Professional Communication and Ethics-II	-	-	-	-	-	25	25	50
CEM501	Mini Project – 2A	-	-	-	-	-	25	25	50
Total		**100**			**400**	**-**	**150**	**150**	**800**

*** Theory class to be conducted for full class**
$ indicates work load of Learner (Not Faculty), for Mini Project

Undergraduate Program Structure for Third year Civil Engineering
University of Mumbai
(With Effect from A.Y. **2021-2022**)
Semester - V

Department Level Optional Course – 1

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

Undergraduate Program Structure for Third year Civil Engineering
University of Mumbai
(With Effect from A.Y. **2021-2022**)
Semester VI

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

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

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

Undergraduate Program Structure for Third year Civil Engineering

University of Mumbai

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

Semester - VI

Department Level Optional Course – 2

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

Program Structure for Third Year Engineering
Semester VII & VIII
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)
Semester - VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC701	Design & Drawing of Reinforced Concrete Structures	03	-	-	03	-	-	03
CEC702	Quantity Survey, Estimation and Valuation	03	-	-	03	-	-	03
CEDLO701X	Department Level Optional Course – 3	03	-	-	03	-	-	03
CEDLO702X	Department Level Optional Course – 4	03	-	-	03	-	-	03
CEILO701X	Institute Level Optional Course – 1	03	-	-	03	-	-	03
CEL701	Design & Drawing of Reinforced Concrete Structures	-	02	-	-	01	-	01
CEL702	Quantity Survey, Estimation and Valuation	-	02	-	-	01	-	01
CEP701	Major Project – I	-	06$	-	-	03	-	03
Total		**15**	**10**	**-**	**15**	**05**	**-**	**20**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC701	Design & Drawing of Reinforced Concrete Structure	20	20	20	80	04	-	-	100
CEC702	Quantity Survey, Estimation and Valuation	20	20	20	80	04	-	-	100
CEDLO701X	Department Level Optional Course – 3	20	20	20	80	03	-	-	100
CEDLO702X	Department Level Optional Course – 4	20	20	20	80	03	-	-	100
CEILO701X	Institute Level Optional Course – 1	20	20	20	80	03	-	-	100
CEL701	Design & Drawing of Reinforced Concrete Structure	-	-	-	-	-	25	25	50
CEL702	Quantity Survey, Estimation and Valuation	-	-	-	-	-	25	25	50
CEP701	Major Project – I	-	-	-	-	-	50	-	50
Total		**100**			**400**	**-**	**100**	**50**	**650**

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

Undergraduate Program Structure for Final year Civil Engineering

University of Mumbai

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

Semester - VII

Department Level Optional Course – 3

Sr. No.	Course Code CEDLO701X	Department Level Optional Course – 3
1	CEDLO7011	Prestressed Concrete
2	CEDLO7012	Applied Hydrology and Flood Control
3	CEDLO7013	Appraisal and Implementation of Infra Projects
4	CEDLO7014	Analysis of Offshore Structures
5	CEDLO7015	Advanced Construction Technology
6	CEDLO7016	Pavement Materials Construction and Maintenance

Department Level Optional Course – 4

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

Institute Level Optional Course – I

Sr. No.	Course Code CEILO701X	Institute Level Optional Course – I
1	CEILO7011	
2	CEILO7012	

3	CEILO7013	

Undergraduate Program Structure for Final year Civil Engineering
University of Mumbai
(With Effect from A.Y. **2022-2023**)
Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC801	Construction Management	03	-	-	03	-	-	03
CEDLO801X	Department Level Optional Course – 5	03	-	-	03	-	-	03
CEDLO802X	Department Level Optional Course – 6	03	-	-	03	-	-	03
CEILO801X	Institute Level Optional Course – 2	03	-	-	03	-	-	03
CEL801	Construction Management	-	02	-	-	01	-	01
CEP801	Major Project – II	-	12$	-	-	06	-	06
Total		**12**	**14**	**-**	**12**	**07**	**-**	**19**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract. /Oral	Total
		Test - I	Test – II	Avg.					
CEC801	Construction Management	20	20	20	80	03	-	-	100
CEDLO801X	Department Level Optional Course – 5	20	20	20	80	03	-	-	100
CEDLO802X	Department Level Optional Course – 6	20	20	20	80	03	-	-	100
CEILO801X	Institute Level Optional Course – 2	20	20	20	80	03	-	-	100
CEL801	Construction Management	-	-	-	-	-	25	25	50
CEP801	Major Project – II	-	-	-	-	-	50	100	150
Total		**80**			**320**	**-**	**75**	**125**	**600**

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

Undergraduate Program Structure for Final year Civil Engineering

University of Mumbai

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

Semester VIII

Department Level Optional Course – 5

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

Department Level Optional Course – 6

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

Institute Level Optional Course-2

Sr. No.	Course Code CEILO801X	Institute Level Optional Course-2

1	CEILO8011	
2	CEILO8012	
3	CEILO8013	

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

Semester V

Semester-V

Course Code	Course Name	Credits
CEC501	Theory of Reinforced Concrete Structures	03

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

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

Rationale

Working Stress Method (WSM) makes use of the concept of modular ratio based on the higher factor of safety in evaluating the stresses in two different materials of the RCC i.e., steel and concrete. The Limit State Method (LSM) is based on the statistical probability which provides the rational solution to the design problems. The philosophy which lies behind, LSM uses multiple safety factors format which attempts to provide adequate safety at the ultimate load as well as adequate serviceability at service load by considering all possible limit states. The subject involves the application of working stress method and limit state method in the analysis and design of various elements of the civil engineering structures.

Objectives

1 To develop clear understanding of design philosophy amongst the students for the design of reinforced concrete structure using working stress method (WSM) and limit state method (LSM).

2 To study various clauses of IS: 456-2000 and their significance in the RCC design.

3 To apply various concepts of LSM in the analysis and design of beams, slabs and columns.

4 To study the concept of Serviceability and Durability for deflection and crack width calculation in RCC structures.

5 To develop the concept of design using design charts and curves for columns subjected to axial load and moment.

6 To study the concept of reinforced concrete footing design subjected to axial load and moment.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Working Stress Method:**		06
	1.1	Concept of reinforced concrete, Working Stress Method (WSM) of design for reinforced concrete, permissible stresses as per IS:456-2000; stress- strain curve of concrete and steel, characteristics of concrete and steel reinforcement.	
	1.2	Concept of balanced, under reinforced and over reinforced sections.	
	1.3	Analysis and design of singly reinforced and doubly reinforced rectangular beams for Flexure.	
2	**Limit State Method:**		03
	2.1	Introduction to limit state method of design as per IS:456-2000.	
	2.2	Concepts of probability and reliability, characteristic load, characteristic strength, partial safety factors for loads and materials, introduction to various limit states of collapse and serviceability.	
3	**Limit State of Collapse: Flexure, Shear, Bond and Torsion:**		12
	3.1	Design of singly and doubly reinforced Rectangular and Flanged sections for flexure, shear and bond.	
	3.2	Design of beams subjected to bending, shear and torsion.	
4	**Design of Slabs using Limit state method:**		04
	4.1	Design of simply supported one-way slabs as per IS:456-2000.	
	4.2	Design of simply supported two-way slabs as per IS:456-2000.	
5	**Limit State of Collapse – Compression:**		08
	5.1	Limit state of collapse: compression for short and slender column.	
	5.2	Introduction to Members subjected to combined axial and uniaxial as well as biaxial bending.	
	5.3	Development of interactive curves and their use in column design.	
6	**Design of Foundations:**		06
	6.1	Design of Isolated square and rectangular footings subjected to axial load and moment.	
	6.2	Introduction to basic concepts of combined rectangular pad footing, slab beam type footing and Raft foundation.	
		Total	**39**

Contribution to Outcome

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

1. Understand the fundamentals of WSM and LSM.
2. Apply various clauses specified in IS: 456-2000 for designing structural members with safety and economy.
3. Understand the use of readymade design charts and curves from Special Publications of Bureau of Indian Standards.
4. Analyze and design various reinforced concrete elements such as beam, slab, column, footings using the concept of Limit State Method.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

1. **Use of IS:456-2000 shall be allowed in the examination.**
2. Question paper will comprise of total six questions, each carrying 20 marks.
3. Question 1 will be compulsory and should cover maximum contents of the curriculum.
4. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
5. Four questions need to be solved in total.

Recommended Books:

1. Design of Reinforced Concrete Structures: Dayaratnam, P; Oxford and IBH.
2. Limit State Design of Reinforced Concrete: Jain A. K, Nemchand and Bros., Roorkee
3. Limit State Design of Reinforced Concrete: Shah and Karve, Structure Publications, Pune.
4. Ultimate Strength Design for Structural Concrete: Arthur, P. D. and Ramakrishnan, V., Wheeler and Co. Pvt. Ltd.
5. Reinforced Concrete: H.J. Shah, Charotar Publishers, Anand.
6. Fundamentals of Reinforced Concrete: Sinha & Roy, S. Chand and Co. Ltd.
7. Illustrated Reinforced Concrete Design: Dr. V. L. Shah and Dr. S. R. Karve, Structure Publications, Pune.
8. Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A, John Wiley (2007), 7th Edition.
9. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.

Reference Books:

1. Design of RCC structural Elements (RCC Vol-I): Bhavikatti, S. S., New Age International Publications.
2. Reinforced Concrete: Syal and Goel; Wheeler Publishers.
3. Reinforced Concrete Design: Pillai, S.U. and Menon, Devdas, Tata Mc-Graw Hill Publishing House, New Delhi.
4. Reinforced Concrete Design by S.N. Sinha, Tata Mc-Graw Hill Publishing House, New Delhi
5. Theory of Reinforced concrete structures by N. Subramanian, Oxford University Press.
6. RCC Design (WSM and LSM): Punmia, B. C., Jain, A. K., and Jain, Arun, K., Laxmi Publications.
7. Limit State Design of Reinforced Concrete (as per IS: 456-2000): Punmia, B. C., Jain, A. K., and Jain, Arun, K., Laxmi Publications.
8. Relevant IS Codes: BIS Publications, New Delhi.

Semester-V

Course Code	Course Name	Credits
CEC502	Applied Hydraulics	03

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

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

Rationale

The knowledge of this course is essential to understand facts, concepts of impact of jets, Miscellaneous Hydraulic Machinery. Further it helps to understand the design aspects, components, function and uses of centrifugal pump, turbines. It also helps to study the concept of uniform Flow Through Open Channels, Non-Uniform Flow Through Open Channels.

Objectives

The students will be able to learn:

1 To introduce the concept of impact of jets.

2 To study hydraulic machines like centrifugal pumps and turbines.

3 To study various Miscellaneous Hydraulic Machinery.

4 To study the uniform flow through open channels and design of most economical section.

5 To study the non-uniform flow through open channels.

Detailed Syllabus

Module	Course Module / Contents	Periods
1	**Impact of Jets** Impulse momentum principle, Jet striking flat plates, stationary and moving vertical, inclined plates, hinged plates, curved vanes, series of plates and vanes mounted on wheel, concept of velocity triangles.	07
2	**Hydraulic Turbines** General layout of hydro-electric plant, heads, efficiencies of turbine, classification, concept of velocity triangles working of Impulse Turbine (Pelton Wheel), Reaction Turbine, Francis Turbine, Kaplan Turbine, draft tube theory, specific speed, unit quantities, Characteristic curves, Cavitation.	08
3	**Centrifugal Pumps** Work done, heads, efficiencies, Minimum speed: series parallel operation, Multistage pumps, concept of velocity triangles, specific speed, model testing, priming, characteristic curves, NPSH, cavitation.	04
4	**Miscellaneous Hydraulic Machinery** Hydraulic Ram, Press, Accumulator, Intensifier, Crane and Lift.	03
5	**Uniform Flow Through Open Channels** Uniform Flow: Flow through open channel: Definition, types of channels, Prismatic, non-prismatic channels, Types of flows in channels, Uniform flow: steady flow and unsteady flow, laminar and turbulent flow, subcritical flow, supercritical flow, Chezy's formula, Manning's formula, hydraulically efficient channel cross-sections (most economical sections).	07
6	**Non-Uniform Flow Through Open Channels** Concept of Specific energy and specific energy curve, Dimensionless specific energy discharge curve, applications of specific energy and Momentum principle to open channel flow, specific force. Gradually varied flow, equation for gradually varied flow, back water curve and afflux, Introduction to surface profiles, Hydraulic jump and standing wave.	10
	Total	39

Contribution to Outcome

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

1 Describe impact of jet on stationary, moving, hinged and series of plates also solve the numerical based on forces acting on it.
2 Distinguish various types of turbines, Characteristic curves and its components.
3 Analyze Centrifugal pumps by incorporating velocity triangle diagrams.
4 Know the working mechanism of various Hydraulic machines.
5 Identify the hydraulic behaviour of open channel flow and design the most economical section of channels.
6 Explain mathematical relationships for hydraulic jumps, surges, and critical, uniform, and gradually-varying flows.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

1 Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi.
2 Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
3 Fluid Mechanics: Dr. A.K Jain, Khanna Publishers.
4 Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538.
5 Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons.
6 Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.
7 Flow through open channels, K.G. Ranga Raju. (1993) : New Delhi : Tata McGrawHill, c1993.
8 Flow Through Open Channels. Rajesh Srivastava (2007): Oxford University Press, 2007, pbk, 432 p, ISBN: 0195690385.

Reference Books:

1. Fluid Mechanics: Frank M. White, Tata Mc-Graw Hill International Edition.
2. Fluid Mechanics: Streeter White Bedford, Tata Mc-Graw International Edition.
3. Fluid Mechanics with Engineering Applications: R.L. Daugherty, J.B. Franzini, E.J. Finnemore, Tata Mc-Graw Hill, New Delhi.
4. Hydraulics: James F. Cruise, Vijay P. Singh and Mohsen M. Sherif, CENGAGE Learning India (Pvt.) Ltd.
5. Introduction to Fluid Mechanics: Edward J. Shaughnessy, Jr, Ira M. Katz, James P. Schaffer. Oxford Higher Education.
6. Open channel Hydraulics: Chow, V.T., McGraw Hill International, New York.
7. Open Channel Flow: Henderson F.M., McGraw Hill International, New York.

Semester-V

Course Code	Course Name	Credits
CEC503	Geotechnical Engineering-I	03

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

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

Rationale

Around all civil engineering structures are supported by soil and rock. Rock is rarely occurring and hence, mostly the supporting medium is soil. The stability of structure depends on the stability of supporting medium. Therefore, geotechnical analysis is required to be carried out. Geotechnical analysis depends on the basic understanding of physical properties of soil which are useful for determining the strength, compressibility, drainage characteristics etc. Soil mechanics is the basic tool for geotechnical engineering, which is the specialized section of civil engineering. Soil is also used as a construction material to build various civil structures, viz., dams, embankment etc. Thus, it is very essential to understand various concepts involved in this course of Geotechnical Engineering-I.

Objectives

1. To study origin and mode of formation of soil as well as functional relationships among different unit weights, volumetric ratios, and water content.
2. To study clay mineralogy and plasticity characteristics of soils.
3. To comprehend particle size distribution and classification of soils as per IS code.
4. To study permeability and seepage flow of water through the soil.
5. To understand the concept of total stress, neutral stress and effective stress in soil.
6. To understand compaction characteristics of soils as well as the techniques of soil exploration, assessing the subsoil conditions and engineering properties of various soil strata.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction to Geotechnical Engineering, Basic Definitions & Relationships**		07
	1.1	Definitions and scope of Geotechnical Engineering: rocks, soil, origin & mode of formation and types of soil obtained, soil mechanics, rock mechanics, geotechnical engineering.	
	1.2	Soil phase systems, volumetric ratios: void ratio, porosity, degree of saturation, air voids, air content.	
	1.3	Weight-volume relationship: different unit weights, water content, specific gravity of soil solids, mass and absolute specific gravity.	
	1.4	Functional relationships among different unit weights, volumetric ratios, and water content.	
	1.5	Relative density, relative compaction.	
	1.6	Different methods to determine water content, specific gravity and unit weight of soil.	
2	**Clay Mineralogy and Plasticity Characteristics of Soils**		06
	2.1	Explanation about clay minerals, e.g., Montmorillonite, Illite and Kaolinite; formation of clay minerals and their role in plastic behavior of soil.	
	2.2	Definition of plasticity of soil, consistency of soil, definition & determination of liquid limit, plastic limit, shrinkage limit.	
	2.3	Definitions of shrinkage parameters, plasticity index, liquidity index, consistency index, flow index, toughness index, activity, sensitivity and thixotropy of soil. Importance of consistency limits.	
3	**Particle Size Distribution and Classification of Soils**		06
	3.1	Wet & dry sieve analysis, Sedimentation analysis: Stoke's law, Hydrometer method of analysis, Limitation of sedimentation analysis.	
	3.2	Particle size distribution curve/ gradation curve and its uses. Introduction to cohesive and cohesionless soil.	
	3.3	Necessity of soil classification, Indian standard particle size classification, Indian standard soil classification system as per IS: 1498 -1970, boundary classification.	
4	**Permeability of Soils & Seepage Analysis**		08
	4.1	Types of soil water, definition of hydraulic head, hydraulic gradient, Darcy's law, validity of Darcy's law, permeability of soil.	
	4.2	Determination of coefficient of permeability of soil in lab using constant head and variable head methods, factors affecting permeability of soil, effect of permeability on various properties of soil, determination of in-situ permeability with pumping out and pumping in tests.	

	4.3	Permeability of stratified soil deposits.	
	4.4	Definition of seepage and its importance for the analysis & design of hydraulic structures, graphical representation of seepage by flow net diagram, definition of flow line, equipotential line, flow channel, flow field, characteristics of flow net, use of flow net, phreatic line.	
	4.5	Factor of safety against piping failure.	
5	**Effective Stress Principle**		**05**
	5.1	Definition of geostatic stresses, total stress, neutral stress/ pore water pressure, effective stress.	
	5.2	Effect of water table fluctuations, surcharge, capillary action, seepage pressure on effective stress; quick sand condition.	
6	**Compaction of Soil & Soil Exploration**		**07**
	6.1	Theory of compaction, determination of optimum moisture content (OMC) & maximum dry density (MDD) in laboratory by conducting the light and heavy compaction tests.	
	6.2	Factors affecting the compaction, effect of compaction on properties of soil, soil structure, placement water content, relative compaction, Proctor needle method for compaction.	
	6.3	Necessity of soil exploration, methods of soil investigation, methods of boring, disturbed and undisturbed soil samples, soil sampling and samplers, number and spacing of bore holes, depth of bore holes.	
	6.4	Penetrometer tests: SPT, SCPT and DCPT.	
	6.5	Representation of data with borehole logs.	
		Total	**39**

Contribution to Outcome

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

1 Explain the basic concepts of the physical and engineering properties of soil and derive the relationships among various unit weights & other parameters.

2 Comprehend clay mineralogy and plasticity behavior of clay.

3 Analyze grain size distribution of soil and classify the soil as per IS code.

4 Evaluate the coefficient of permeability of different types of soils and draw the flow net diagram to estimate seepage discharge.

5 Compute the effective stress and pore water pressure inside the soil mass under different geotechnical conditions.

6 Evaluate the compaction parameters in laboratory and field as well as understand the necessity and methods of soil exploration.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

1. Basic and Applied Soil Mechanics: Gopal Ranjan, A S R Rao; New Age International Publishers.
2. Soil Mechanics and Foundation Engineering: V. N. S. Murthy; CBS Publishers & Distributors
3. Soil Mechanics and Foundation Engineering: K. R. Arora; Standard Publishers and Distributors, New Delhi.
4. Soil Mechanics and Foundations: B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain; Laxmi Publications (P) LTD., New Delhi
5. Geotechnical Engineering: C. Venkatramaiah; New Age International Private Limited
6. Fundamentals of Soil Engineering: D. W. Taylor; John Wiley & Sons.

Reference Books:

1. An Introduction to Geotechnical Engineering: Robert D. Holtz, William D. Kovacs; Prentice-Hall, New Jersey
2. Soil Mechanics: R. F. Craig; Spon Press, Taylor and Fransis Group
3. Soil Mechanics: T. W. Lambe, R. V. Whitman; John Wiley & Sons
4. Relevant Indian Standard Specifications Codes, BIS Publications, New Delhi
5. Soil Mechanics in Engineering Practice: Karl Terzaghi, Ralph B Peck, Gholamreza Mesri; John Wiley & Sons

Semester-V

Course Code	Course Name	Credits
CEC504	Transportation Engineering	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
04	-	-	04	-	-	04

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

Rationale

An efficient transportation system is essential for sustainable economic development of the country and plays a significant role in promoting national and global integration. An efficient Transportation system helps in increasing productivity and enhances competitiveness of the economy. Hence, the transport sector is considered as an important component of the economy and a common tool used for development. Three basic modes of transportation include land, water and air. The course deals with understanding of basics of different modes of transportation (Highways, railways, airways and waterways). The highways owing to its flexibility in catering door-to- door service is one of the important modes. This course deals with the investigation, planning, design, construction and maintenance of highways in addition to traffic planning, operation and control.

Objectives

1	To understand the technical aspects of Railways, Airways and Waterways.
2	To carry out Planning and design of geometric elements of Highways.
3	To study various traffic studies and to understand elements of Traffic Engineering for efficient planning and control.
4	To study Requirements of Highway materials and to design Rigid and flexible pavements using IRC codes.
5	To study methods of construction of Rigid and Flexible pavements, use of soil stabilization and drainage to highways.
6	To design the overlay on basis of pavement evaluation and failure identification on rigid and flexible pavements.

Detailed Syllabus			
Module	**Course Module / Contents**		**Periods**
1	**Introduction to Transportation Systems**		**10**
	1.1	Introduction to Transportation Engineering, Comparison of various modes of transportation (Roadways, Railways, Airways and Waterways).	
	1.2	Introduction to Railway Engineering: Cross sectional elements of railway track (Foundation, Ballast, Sleepers and Rail), Introduction to turnout, Super elevation design, Negative Super elevation, Construction and Maintenance of Railway track.	
	1.3	Introduction to Airport Engineering: Elements of Airport, Site selection of Airport, Design of Runway length, Taxiway and Exit Taxiway design.	
	1.4	Introduction to Waterways: Definition of Docks, Harbor and Ports. Elements and types of Docks, Harbor and Port.	
2	**Planning and Geometric Design of Highways**		**10**
	2.1	Classification of roads based on various criteria, Road development plans, agencies related to highway development, Highway alignment (basic requirement and factors governing), hill roads, Surveys for highway location.	
	2.2	Terrain Classification, Vehicular Characteristics, Cross section elements of highways (width of carriage way, shoulders, medians, width of road way, right of way, camber & its profile).	
	2.3	Design speed, sight distance, perception time, break reaction time, analysis of safe sight distance, analysis of overtaking sight distance, intersection sight distance.	
	2.4	Horizontal curves: design of super elevation, its provisions, minimum radius of horizontal curves, widening of pavement, transition curves.	
	2.5	Gradients: different types, maximum, minimum, ruling exceptional, grade compensation on curves.	
3	**Traffic Engineering**		**10**
	3.1	Introduction to various traffic studies such as speed study, volume study, parking study, accident study, O&D study etc. Speed study: methods to determine speed, types of speed (Spot speed, Design speed, Upper & lower limit speeds, Mean - Median and Modal speed); Traffic Volume study (flow): Definition, AADT, ADT, Design volume, methods of determining traffic volume. Traffic density: Definition, importance.	
	3.2	Introduction to Relationship between Speed, density and volume. Capacity: Q-K-V curve, Different types and factors affecting capacity, Concept of PCU and LOS.	
	3.3	Introduction to traffic control devices Traffic signs, signals (no design), road marking.	

	3.4	Different types of Intersections-At-grade and Grade Separated; Grade separated interchanges; rotary intersection.	
4	**Pavement Material and Design**		**12**
	4.1	Types of pavements, comparison of flexible and rigid pavements, Requirements of pavement materials, Soil: requirement of soils as subgrade material, CBR test. Aggregate: Requirements of aggregate as Pavement material, Tests on aggregate with specified values. Bitumen: Requirements of bitumen as pavement material test on bitumen with specified values, variants of bitumen (Modified bitumen) and its uses. Introduction to Bituminous mix design using Marshall Stability test.	
	4.2	Flexible pavement design: Concepts related to flexible pavement design such as tyre pressure, contact pressure, ESWL, VDF and LDF. IRC approach for design (IRC: 37- 2001, IRC: 37- 2012), also IRC SP 72-2007/2015 and IRC 77 2008.	
	4.3	Rigid pavement design: Modulus of subgrade reaction, equivalent radius of resisting section, radius of relative stiffness, stresses on rigid pavement, combine loading temperature stress.; Design of rigid pavements (IRC: 58- 2002; IRC: 58- 2011, IRC: 58- 2015. IRC: SP- 62-2004, IRC: SP- 62-2014)	
5	**Pavement Construction, Soil Stabilization and Drainage**		**05**
	5.1	Construction of different types of roads: water bound macadam (WBM) road, WMM, bituminous pavements, cement concrete pavement. And joint (As per IRC, MORTH specifications) jointed reinforced, continuously reinforced; fiber reinforced; roller compacted concrete pavements.	
	5.2	Soil Stabilization: Significance, Principle of soil stabilization, different methods of soil Stabilization, use of Geosynthetics in highways and allied structures.	
	5.3	Highway drainage: Necessity/ Significance, mode of ingress of water in highway structure, Different methods of drainage- surface and subsurface drainage inkling for the roads in hilly areas.	
6	**Pavement Evaluation, Failures and Maintenance**		**05**
	6.1	Evaluation of pavement, Structural and functional evaluation, methods of structural evaluation (working of Benkelman beam, FWD, LWD), methods of functional evaluation (working of Bump indicator, profilometric systems)	
	6.2	Distress / failure in Rigid and flexible pavement, reasons and measures.	
	6.3	Strengthening of existing pavement, Overlay and its types, design of overlay (Benkelman beam method)	
		Total	**52**

Contribution to Outcome

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

1. Compare various modes of transportation and understand basic technical aspects of railways, airways and waterways.
2. Understand different road plans, requirements of alignments and Design horizontal and vertical geometrical elements of highways.
3. Carry out different traffic studies and analyze basic parameters of traffic engineering for efficient planning and control of traffic.
4. Design the flexible and rigid pavement as per relevant IRC codes.
5. Construct different types of pavements, use of soil stabilization and planning of highway drainage.
6. Carry out structural and functional evaluation of pavement, identify the failures and design the overlay.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

1. A Course of Railway Engineering: Saxena, S. C. and Arora, S. P.; Dhanpat Rai Sons, New Delhi.
2. Airport Planning Design: Khanna, S.K., Arora, M.G.and Jain, J.J.;Nemchand Bros., Roorkee.
3. Docks and Harbour Engineering: Bindra, S. P.; Dhanpat Rai and Sons,New Delhi.
4. Highway Engineering: Khanna, S.K. and Justo, C. E. G.; Nem Chand and Bros., Roorkee.
5. Principles, Practice and Design of Highway Engineering (Including Airport Engineering)" Sharma, S.K.; S. Chand and Company Pvt. Ltd., New Delhi.
6. Highway Material and Pavement Testing: Dr. S. K. Khanna, Dr. C. E. G. Justo and Dr. A. Veeraragavan. Nem Chand and Bros., Roorkee, India.

Reference Books:

1 Indian Railway Track: Agarwal, M. M., Suchdeva Press New Delhi.

2 Planning Design of Airport: Horonjeff Mckelrey, Tata Mc-Graw Hill India Publishing House, New Delhi.

3 Design and Construction of Ports and Marine Structures: Quinn, A. D., Tata Mc-Graw Hill India Publishing House.

4 Transportation Engineering and Planning: C.S. Papacostas and P.D. Prevedouros; Prentice Hall India Learning Pvt. Ltd., New Delhi.

5 Principles of Transportation Engineering: Chakrabory, Partha and Das, Animesh; Prentice Hall India Learning Pvt. Ltd., New Delhi.

6 Transportation Engineering: Khisty, C.J. and Lall, Kent, B.; Prentice Hall India Learning Pvt. Ltd., New Delhi.

7 Traffic Engineering and Transport Planning: Kadiyali, L.R., Khanna Publishers, Delhi.

8 Principles and Practice of Highway Engineering: Kadiyali, L. R.; Khanna Publsihers, Delhi.

9 Relevant specifications of MORTH and relevant IRC codes.

Semester-V

Course Code	Course Name	Credits
CEDLO5011	Department Level Optional Course - 1 Modern Surveying Instruments and Techniques	03

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

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

Rationale

Revolutionary changes have taken place in the last few years in surveying instruments and techniques that are used for measuring level differences, distances, angles, areas, volumes, etc. This has become possible due to the advent of electronics in the surveying instruments. With rapid advancements in the technology and availability of cheaper and innovative electronic components, these instruments have become affordable and user friendly.

This course outlines the advancements in instruments and techniques such as digital levels, electronic distance measuring instruments, electronic theodolites, total stations, GPS, GIS, Remote Sensing, drone survey, aerial photogrammetry and hydrographic survey. It also makes the learner industry-ready with respect to the applications of the modern tools in data capturing and further in mapping using appropriate software.

Objectives

1. Understand the working principles and methodologies of modern surveying instruments and compare with conventional instruments.
2. Exhibit the concepts of Global Positioning System, Geographical Information system and remote sensing techniques.
3. Demonstrate the importance of Aerial photogrammetry in surveying works,
4. Develop recent methods of maintaining land records,
5. Study the art of delineating the levels underwater bodies.
6. Highlight the modern techniques in the field of surveying and mapping using various softwares.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction to Modern Surveying Instruments:**		06
	1.1	Principles governing modern instruments and comparison with the conventional instruments.	
	1.2	E.D.M. Electromagnetic spectrum, Electromagnetic distance measurement, Instruments – Digital planimeter, Auto Level, Laser Level, Electronic Digital Theodolite, Total Station, Scan station, Smart Station (Total station with GPS).	
2	**Geoinformatics**		12
	2.1	Global Positioning System- Global Positioning System – working principle and methods, Different Approaches to use GPS and their accuracies, Advantages of GPS in Navigation, Survey, Planning and Mapping.	
	2.2	Geographical Information System -Introduction, Definition, Objectives, Components (people, procedure, hardware, software & data) & functions (input, manipulation, management, query & analysis and visualization) of GIS. Coordinate systems and projections, Geo-referencing, GIS data – spatial (Raster & vector) & spatial data. Introduction to vector and raster data analysis such as network analysis, overlay analysis etc. for vector, DEM, Management of a spatial data.	
	2.3	Remote Sensing introduction, Definition, Necessity, Importance and use; Basic concepts in Remote Sensing, Basic Laws of electromagnetic radiation, Atmospheric effects on radiation, Interaction of EM energy with matter, Resolution in remote sensing, Satellite remote sensing, Problems confronting remote sensing system. Ideal and Real remote sensing systems.	
3	**Aerial Photogrammetry**		06
	3.1	Introduction, principle and uses of Aerial photographs, Definitions, of different terms, Scale of vertical and tilted photograph (simple problems), Ground Coordinates.	
	3.2	Relief Displacements, Ground control, Procedure of aerial survey, overlaps and mosaics, Stereoscopes	
4	**Cadastral Surveying**		04
	4.1	Cadastral Surveying: Contemporary Techniques of maintaining survey records, 7-12 Extracts, Form-8 (Namuna-8).	
	4.2	Role of Survey Department, Role of revenue department. Soft/digitized formats of land records, Comparison with conventional record keeping	
5	**Hydrographic Surveying**		04
	5.1	Hydrographic Surveying: Objects, Applications, establishing controls, Shore line survey, Sounding, sounding equipment, Methods of locating soundings – conventional and using GPS.	

	5.2	Reduction of soundings, Plotting of soundings, Nautical sextant and its use, Tides and tide gauges, determination of MSL.	
6	**Applications of Modern Survey Techniques and Map Preparation Using Software**		**07**
	6.1	Applications of Total Station, GIS, GPS, Remote sensing, LIDAR, Drones in Civil Engineering.	
	6.2	Introduction of GRAM++, Q-GIS, Map Info etc.	
		Total	**39**

Contribution to Outcome

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

1 Compare modern surveying instruments with conventional instruments.

2 Elucidate the utility of geoinformatics in surveying data collection and analysis.

3 Explain the utility of Aerial photogrammetry in surveying works.

4 Highlight the improvement in land record keeping and governance using modern tools.

5 Describe the procedure of hydrographic surveying and mapping.

6 Apply modern surveying tools to solve complex problems and demonstrate essential skills for working on surveying software.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only four questions need to be solved in total.

Recommended Books:

1 Agor R, Advanced Surveying, Khanna Publishers, New Delhi (ISBN9788174909053).

2 Kanetkar, T.P. and Kulkarni, S.V., Surveying and Levelling Vol. II, Pune Vidhyarthi Gruh Publication (ISBN9782508807185).

3 Arora, K.R., Surveying Vol. III, Standard Book House. New Delhi (ISBN9788189401276).

4 Basudeb Bhatta, Remote Sensing and GIS, Third Edition, Oxford University Press, New Delhi. ISBN: 9780199496648

5 B. C. Punmia, Ashok K Jain, Arun K Jain, Advance Surveying, Laxmi Publications (ISBN 9788170088530)

6 R. Subramanian, Surveying and levelling, Oxford University Press, New Delhi (ISBN9780198085423)

7 P.Dong , Q.Chen, Lidar Remote Sensing and applications ,CRC Press (ISBN 9781138747241)

Reference Books:

1 Basudeb Bhatta, Remote Sensing and GIS, Third Edition, Oxford University Press, New Delhi. ISBN: 9780199496648

2 T.M Lillesand, R.W Kiefer, and J.W Chipman, Remote sensing and Image interpretation, 5th edition, John Wiley and Sons, India; ISBN: 978-1-118-34328-9

3 Kaplan E.D and Hegarty C.J., Understanding GPS: principles and applications, Artech House (ISBN978-1-63081-058-0)

4 Wolf P.R. and Dewitt B.A., Elements of Photogrammetry, McGraw Hill,(ISBN 978-0072924541)

5 DeMers M.N., Fundamentals of GIS, John Wiley (ISBN978-0470129067)

6 Gibson P.J., Introductory Remote Sensing: Principles and Concepts, Routledge (ISBN0 415 18962 4).

Semester-V

Course Code	Course Name	Credits
CEDLO5012	Department Level Optional Course - 1 Building Services and Repairs	03

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

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

Rationale

The building services are based on engineering operations of buildings & the built environment. Building services are responsible for the environment in which we live & work. Building service systems are complex. They are typically a major source of cost & potential problems in building service conditions. Fundamental knowledge of how mechanical, electrical, plumbing & other systems work & interact is important to the construction professionals. This course provides an introduction to building service systems which include the study of design, interfaces & specifications of various building services in buildings. For an existing building, it is necessary to be in a good condition to perform the intended functions. Adequate maintenance extends the building life & ensures the safety of occupants. Most of the structures are getting old & are in the dire need of the repair and maintenance. Hence, there is a huge employment potential in conformity with the field of repair and maintenance. This course, therefore, finds its place in the curriculum such that the pupils can acquire the competency in this area. The course deals with the different building services, health monitoring of buildings, their maintenance, repair materials and repair methodologies.

Objectives

1 To understand the concepts of mechanical systems in buildings such as lifts, escalators, HVAC systems, pumps & their applications.

2 To understand design concepts of electrical system, safety and illumination fundamentals.

3 To get familiar with the plumbing system and services in buildings related to water supply, drainage, gas supply and firefighting installations.

4 To learn about causes of distress of concrete structures and learn various instrumental testing methods for Condition assessment & evaluation of structure and assess the extent of repairs.

5 To acquire the knowledge of repair materials and repair methodologies for rehabilitation of RCC structures.

6 To learn implementing repair process and to follow safety during construction work.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Building services: Mechanical systems.**		06
	1.1	Lifts/elevators, escalators, conveyors: their components, capacity and principles of working, common problems.(3L)	
	1.2	Motors, Generators, Pumps, HVAC Systems - Heating systems, Cooling Systems, Packaged HVAC, types, capacity, components and their principles of working, common problems.(3L)	
2	**Building services: Electrical systems & Illumination in Buildings**		07
	2.1	Electrical grids and supply system: Layout of substations Transformers & switch gears, Main & distribution boards, electrical systems in buildings, Single / Three phase supply, ISI specifications, electrical load, electrical layout plan in a building, Types of wires, wiring system & their choice, Solar energy, CCTV, LAN. Protective devices in electrical installation: Earthing for safety, Types of Earthing, fuses, circuit breakers, lightening arrester.(4L)	
	2.2	Principles of Illumination Design: Visual task, Factors affecting visual task, Luminous flux, candela, solid angle illumination, utilization factor. Modern theory of light &color: Synthesis of Light, Additive & Subtractive synthesis of colour, classification of lighting, artificial lights sources, spectral energy distribution, luminous efficiency, color temperature, colour rendering. Level of illumination: Lighting for stores, offices, school, hospitals and house lighting, elementary idea of special features required and minimum level of illumination required in buildings.(3L)	
3	**Building services: Plumbing Systems in Building**		06
	3.1	Water Distribution system: Material for service pipes, service connection, size of service pipe, Water meter, valves and storage tanks, water requirement for domestic use and firefighting.(2L)	

	3.2	Drainage system: Pipe and traps, system of plumbing, house drainage plans, Chambers- gradient and spacing, manholes, septic tanks and soak pit, Introduction to rain water harvesting system.(2L)	
	3.3	Other plumbing systems: Fire safety, fire-fighting installations, types and purpose, piped gas supply systems, AC ducting.(2L)	
4	**Deterioration of Concrete Structures & Condition assessment**		**06**
	4.1	Durability & Causes of deterioration of concrete structures: effects of climate, moisture, temperature, chemical, wear, erosion & loading on serviceability & durability. Design errors & construction errors, causes of seepage & leakage in concrete structures, formation of cracks including those due to corrosion.(2L)	
	4.2	Condition Survey, Evaluation & Damage Assessment: Structural audit and bye laws. Diagnostic methods & analysis. Destructive, semi-destructive and non-destructive methods: core test, carbonation test, chloride test, petrography, corrosion analysis, cover meter test, rebound hammer test, ultrasonic pulse velocity test, and crack measurement techniques, Concrete endoscopy & thermal imaging, pull- off test & pull-out test.(4L)	
5	**Repair Materials & Methodologies For Repairs**		**08**
	5.1	Repair analysis, Repair materials: and their desired properties, Polymer modified mortar/ concrete, micro concrete, bonding chemicals, protective materials and their properties for moisture barrier systems, water-proofing of concrete structures, Systems like integral, crystalline, coatings, membranes, joints sealants, crack repair fillers, corrosion resistant steels, Pre-packed zinc sacrificial anode, Snap-On zinc mesh anode CP system, corrosion inhibitors, rust solvents.(4L)	
	5.2	Repair methodologies: Crack and patch repair, Injection grouting, surface coatings, column jacketing, guniting, shotcrete, Ferroconcrete, FRP, Carbon fiber wrapping, methods of rebar corrosion protection, cathodic protection.(4L)	
6	**Repair Process Implementation and Safety During Repairs**		**06**
	6.1	Legal Documentation and Records: Estimates of repair work, procedure and flow chart for repairs, Bill of quantities, Tendering, Work order, Agreement and Contract, Measurement book, bills, security deposits, role of PMC.(3L)	
	6.2	Safety during Repairs: Causes of accidents, safety signs, barricading, insurance, Temporary Support structures such as, formwork, shuttering, centering, staging and scaffolding.(3L)	
		Total	**39**

Contribution to Outcome

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

1 Apply the knowledge of working & installation of mechanical utility services in buildings.
2 Understand the electrical supply lines, materials, safety devices and illumination systems used in buildings.
3 Investigate and learn operations and adopt appropriate materials in plumbing systems & integrate the same into the building projects.
4 Assess the structural health of the buildings & adopt repair strategy to the damaged structures.
5 Implement the right methods and materials for repairing the concrete structures and also decide the sequence of operations.
6 Create and understand proper documentation process and adopt practices for safety for protection of men and materials on the repair site.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

1 Heat Pumps and Electric Heating: *E. R. Ambrose*, John and Wiley and Sons, Inc., New York, 1968
2 Handbook for Building Engineers in Metric Systems, NBC, New Delhi, 1968.
3 Philips Lighting in Architectural Design, McGraw-Hill, New York, 1964.
4 The Lighting of Buildings: *R. G. Hopkinson and J. D. Kay*, Faber and Faber, London, 1969.
5 National Building Code.
6 Building Construction: *Dr. B. C. Punmia, Ashok K Jain*, A.K Jain
7 Construction Engineering and Management: *S. Seetharaman*, Umesh Publications, Delhi.
8 Water supply and Sanitory Installations: *A. C. Panchdhari*, New Age International Publication, Delhi

9 Concrete Repair and Maintenance: *Peter H. Emmons and Gajanan M. Sabnis*, Galgotia Publication
10 Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication.
Building Services and Repairs: Dr. A. S. Radke, Tech Knowledge Publications

Reference Books:

1 Guide to Concrete Repair and Protection, HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia
2 CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG (Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf.
3 Guide to Concrete Repair, *Glenn Smoak*, US Department of the Interior Bureau of Reclamation, Technical Service Center, http://books.google.co.in.
4 Management of Deteriorating Concrete Structures: *George Somerville*, Taylor and Francis publication
5 Concrete Building Pathology: *Susan Macdonald*, Blackwell Publishing.
6 Testing of Concrete in Structures: *John H. Bungey, Stephen G. Millard and Michael G. Grantham*, Taylor and Francis Publication.
7 Durability of concrete and Cement Composites: *Page, C.L.* and Page, *M.M.*, Woodhead Publishers
8 Fire Safety in Building: V. K. Jain, New Age International Publication, Delhi
9 MEP systems & Repairs of Buildings: A.S. Radke, Published by Synergy Knowledgeware.

Semester-V

Course Code	Course Name	Credits
CEDLO5013	Department Level Optional Course - 1 Sustainable Building Materials	03

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

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

Rationale

Meeting the needs of the present without compromising the ability of future generations to meet their needs is considered to be the simplest and effective sustainable development. The greatest threats to the sustainable development on earth are: population growth and urbanization, energy use and global warming, excessive waste generation and the subsequent pollution and limited supply of resources. Concrete is the primary construction material in the world. Construction industry consumes 40 percent of the total energy and about one half of world's major resources. Hence, it is imperative to regulate the use of materials and energy in this industry. The largest environmental impact of the concrete industry comes from the cement manufacturing process that leads to relatively high greenhouse gas emissions. Minimizing the quantity of cement in a concrete mix has many potential benefits. Thus, the use of industrial byproducts such as fly ash, silica fume as cementitious materials in concrete structures can lead to significant reduction CO2 emissions and consumption of energy and raw materials. Green and intelligent buildings also have been evolved for sustainability of the construction industry. This course provides knowledge of different sustainable building materials and technologies in construction industry.

Objectives

1 To have more awareness among students about sustainability.

2 To understand environmental issues due to building materials and the energy consumption in manufacturing building materials.

3 To study the alternative masonry unit and mortar for sustainable practices.

4 To know the importance of cement reduction and replacements for a sustainable development.

5 To understand the alternative building technologies which are followed in construction.

6 To have cognizance of alternative roofing systems in practice.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Sustainability**		07
	1.1	Introduction: Need and concept of sustainability, Social Environmental and economic sustainability concepts,	
	1.2	Sustainable development, Nexus between technology and Development, Challenges for sustainable development Fundamentals of sustainability.	
	1.3	Global Environmental issue: Resource degradation, ozone layer Depletion Climate change, Carbon cycle, Factors affecting Carbon credits and carbon trading, carbon foot Print, Carbon sequestration-carbon capture and storage (CCS).	
	1.4	Environment legislation in India-water act and air act	
2	**Energy In Building Materials**		06
	2.1	Embodied energy and life cycle energy, Calculation of embodied energy in wall, Environmental issues concerned to building materials, Global warming and construction industry.	
	2.2	Environment friendly and cost-effective building technologies. Requirements for building of different climatic regions.	
	2.3	Traditional building methods and vernacular architecture Green buildings, Intelligent buildings, green materials, green building ratings-IGBC & LEED.	
	2.4	Renewable and nonrenewable energy sources.	
3	**Elements of Structural Masonry**		06
	3.1	Characteristics of building blocks for walls, Stones and Laterite blocks, Bricks, Fly ash bricks and hollow clay blocks, Concrete Blocks, Stabilized blocks: mud blocks, steam cured blocks, Fal-G Blocks stone masonry block.	
	3.2	Masonry Mortars: Mortars, Cementitious materials: Lime, OPC, PPC, Masonry cement, Lime pozzolana (LP)cement. Sand: natural and manufactured, Classification of mortar as per BIS, Types of mortar, Properties and requirements of mortar, Selection of mortar.	
4	**Cementitious and Supplementary Cementitious Materials and their Characterization:**		06
	4.1	Lime, Lime pozzolana cements, Pozzolana: Surkhi, Fly ash, IS (3812) (Type C and F), GGBFS, Silica Fumes, Metakaolin,	

		RHA, Composite cements and its types, IS (16415:2015), Magnesia based cements, Calcium sulfo- cement, Alkali activated, cement (Type 1 and Type II), Geopolymers. Composition, Properties and uses.	
	4.2	Membrane curing: wax and resin based, self-curing compound: Polymer and polyethylene glycol, Water reducing admixtures, use of treated domestic effluent (TDE) for mixing and curing	
5	**Alternate Building Technologies**		**07**
	5.1	Fiber reinforced cement composites: Matrix materials, reinforcing Materials, Applications	
	5.2	Fiber reinforced polymer composites: Matrix materials, types of polymers used and applications	
	5.3	Ferrocement and ferroconcrete building components: Materials, Construction methods, Mechanical properties, Applications.	
	5.4	Nanotechnology for sustainable construction.	
6	**Alternate Building Materials and Roofing Systems**		**07**
	6.1	Building materials from agro and industrial waste: Typical agro- waste and biomass resources, Use of industrial waste: Fly ash, Blast furnace slag, Iron ore tailings, Gold mine tailings Granite and marble polishing fines, demolished building waste	
	6.2	Concepts in roofing alternatives, Types of roof, Roof as a structural system, Cost reduction through construction process efficiency	
	6.3	Filler slab roofs, Composite beam and panel roofs, construction Details and roof assembly.	
	6.4	Masonry domes and vaults: Relevance, analysis and design, Barrel vault.	
		Total	**39**

Contribution to Outcome

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

1 Explain sustainable practices by utilizing engineering practices.

2 Able to understand different types of environmental problems and their sustainable solution.

3 Suggest appropriate type of masonry unit and mortar for civil engineering constructions.

4 Analyze different alternative building materials for construction.

5 To suggest suitable alternative building technologies for sustainable development.

6 To propose different roofing systems and use of waste materials in construction industry.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

1 Alternative Building Materials and Technologies by KS Jagadish, BV Venkatraman Reddy and KS Nanjunda Rao, New Age International publications.
2 Sustainability Engineering: Concepts, Design and Case studies by Allen D.T, and Shonnard D.R , Prentice Hall.
3 Sustainability Engineering: Concepts, Design and Case studies by Bradley A.S; Adebayo A.O, and Mario P., Cengage learning
4 Sustainability of construction materials by Jamal M Khatib, Woodhead publishing limited.
5 Renewable energy sources by Twidell J.W and Weir A.D, English Language Book Society (ELBS)

Reference Books:

1 ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy efficiency Publications—Rating system, TERI Publications – GRIHA Rating system.
2 Structural Masonry by Arnold W Hendry, Macmillan Publishers
3 Systems Analysis for Sustainable Engineering: Theory and Application by Ni bin Chang, Mc Graw Hill Professional
4 NPTEL course on sustainable materials and green building https://nptel.ac.in/courses/105/102/105102195
5 Relevant codes

Semester-V

Course Code	Course Name	Credits
CEDLO5014	Department Level Optional Course - 1 Advanced Structural Mechanics	03

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

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

Rationale

The structures are subjected to various types of loading/ forces. These are axial force, shear force, bending moment, torsion etc. This course enables the students with the knowledge in conformity with analysis of behaviour of structural members under different types of loading. The course facilitates in imparting theoretical concepts and physical understanding, which in turn will help in solving structural mechanics problems, mostly involving beams & thin-walled structures under different loading conditions.

Objectives

1 To understand the concept of unsymmetrical bending, shear centre and spring & evaluate the stress due to unsymmetrical bending, shear centre for symmetrical & un- symmetrical thin-walled sections.

2 To study the concepts and behavior of beams curved in elevation & to evaluate the stress.

3 To study the concepts and behavior of beams curved in plan subjected to different types of loadings.

4 To understand the concept &behavior of beams resting on elastic foundation.

5 To understand the concept of different theories of failure in regards of materials.

6 To study the behavior of deep beams using different theories available for the analysis of different sections.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Unsymmetrical Bending, Shear Centre and Springs**		07
	1.1	Product of inertia, principal moment of inertia, flexural stresses due to bending in two planes for symmetrical sections, bending of unsymmetrical sections.	
	1.2	Shear Centre for symmetrical & unsymmetrical (about both axes) thin-walled open sections.	
	1.3	Helical springs, flat spiral springs, laminated springs.	
2	**Beams Curved in Elevation**		07
	2.1	Bending of beams with large initial curvature, loaded in their plane of curvature.	
	2.2	Application to analysis of hooks, circular closed rings, chain links with straight length & semi-circular ends.	
3	**Beams Curved In Plan**		05
	3.1	Analysis of Beams Curved in Plan such as cantilever circular arc, semicircular beams fixed at two ends and subjected to central concentrated load.	
	3.2	Simply supported semicircular beam subjected to UDL supported on three equally spaced columns, Analysis of circular ring beam.	
4	**Beams on Elastic Foundation**		07
	4.1	Analysis of beams of infinite length subjected to concentrated force/moment & semi-infinite length subjected to concentrated load/moment at one end.	
	4.2	Semi-infinite beam hinged at one end (origin) & subjected to UDL throughout.	
5	**Theories of Failure**		07
	5.1	Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory.	
	5.2	Maximum total strain energy theory.	
6	**Analysis of Deep Beams**		06
	6.1	Determination of deflection.	
	6.2	Determination of shear correction factor for various sections: rectangular solid & hollow section, circular solid & hollow section & I-section	
		Total	**39**

Contribution to Outcome

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

1 Understand the concept of unsymmetrical bending, shear centre for thin-walled open sections and springs.
2 Analyze hooks, circular closed rings, chain links with straight length & semi-circular ends using the concept of beam curved in elevation.
3 Analyze the beam curved in plan for different support conditions.
4 Study the behavior of beam resting on elastic foundation with various loading conditions.
5 Understand the concept of different theories of failure in different sections.
6 Determine deflection of deep beams, shear correction factor for different sections like solid & hollow sections.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

1 Mechanics of Materials: Popov, E.P. Prentice Hall of India Pvt. Ltd.
2 Advanced Mechanics of Materials: Arthur P. Boresi and Omar M. Sidebottom, Wiley and Sons.
3 Strength of Material Part I and Part II: Timoshenko, McGraw Hill, New York.
4 Mechanics of Solids: Shames, I and Pitarresi, J. M., Preentice Hall, New Delhi.
5 Strength of Materials: Subramanian, Oxford University Press.
6 Advanced Mechanics of Solids, L.S. Srinath, Tata McGraw Hill,20
7 Strength of Materials: R. K. Rajput, S. Chand and Co. Ltd.

Reference Books:

1 Mechanics of Materials: Beer, F.P., E. Russell Jhonston and John T. DeWolf, TMH, New Delhi.
2 Beams on Elastic Foundation: Heteny M.
3 Mechanics of Materials: James Gere, M., Thomson Brooks.
4 Reinforced Concrete Deep Beams: F.K. KONG, Taylor & Francis Books, Inc.

Semester-V

Course Code	Course Name	Credits
CEDLO5015	Department Level Optional Course - 1 Air and Noise Pollution and Control	03

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

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

Rationale

Air pollution is caused by solid and liquid particles and certain gases that are suspended in the air. These particles and gases can come from car and truck exhaust, factories, dust, pollen, mold spores, volcanoes and wildfires, possibly causing diseases, death to humans, damage to living organisms. Noise pollution impacts millions of people on a daily basis. The most common health problem it causes is Noise Induced Hearing Loss (NIHL). Exposure to loud noise can also cause high blood pressure, heart disease, sleep disturbances, and stress. This subject is intended to make students aware about the noise and air pollution, various sources which contribute in degradation of air quality, assessing the air quality through air quality index, and various air and noise pollution control methods and equipment used by industries.

Objectives

The students will be able to learn:

1 Understanding of basic concepts of air and noise pollution.

2 Study of air pollution episodes. Reasoning of the entire episode, identification of the parameters, conditions, mechanisms.

3 Study of sampling types and methods for ambient air and stack.

4 Study of macro and micro meteorology for understanding the dispersion of pollutants.

5 Simple and complex modeling for point source, line source and area source.

6 Study of pollution control methods, mechanism and devices, laws.

Detailed Syllabus

Module	Course Module / Contents	Periods
1	Introduction to Air Pollution: Definition, Air pollutants and its classification and sources of generation. Emission Inventory. Indoor air pollution. Measurement of air pollution. Air pollution in India and other countries. Air Quality Index. Numerical on conversion of units of pollutants.	05
2	Environmental Effects of Air Pollution: Effects of air pollutants on human beings, plants, animals, properties and visibility. Exposure to air pollution. Numerical problems based on COH, CoHb	06
3	Measurement and Control technology of Air Pollutants: methods to measure ambient air pollution and stack emissions, high volume sampler, wind rose diagram. Control Technology: Control Devices Principles, operations and types, simple hoods and ducts. Settling chambers, cyclones, electrostatic precipitators (ESP), Filters, scrubbers, absorption towers and incinerators. Collection efficiencies for laminar and turbulent flows for settling chambers, particle cut size for cyclone, ESP Concept of frictional and overall efficiencies. Design criteria for filters, scrubbers, absorption towers and incinerators.	10
4	Meteorological process and air quality monitoring: Large scale wind circulation geotropic wind, gradient wind, cyclone, anticyclone, planetary boundary layer. Lapse rate, stability conditions, wind velocity profile, maximum mixing depth, topographic effects. Plum patterns, plum dispersion, Gaussian model for predicting concentration, downwind from a single source, diffusion coefficients, Turner's stability categories and graphs for dispersion estimates. Maximum ground level concentration, inversion effects, distance touching ground modification of Gaussian model to predict particulate dispersion, plume rise, modified Holland equation for small source.	10
5	Current Issues on Air Pollution and Global -Legal Aspects, air pollution laws, Indian standards- emission and air quality standards Greenhouse effect/ Global warming, Ozone Pollution, Acid Rain.	04
6	Noise Pollution: definition and introduction, the effects of noise, characteristics of sound and its measurement, levels of noise and problems, noise rating system, noise level standards, sources of noise and their noise levels, noise abatement and control.	04
	Total	**39**

Contribution to Outcome

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

1 Identify air and noise pollution problems and interpret criteria for air and noise quality data.
2 Recognize various environmental transformation processes of pollutants under extreme weather condition.
3 Interpret meteorological data and develop capability to assessment of project proposal.
4 Knowledge to analyze quality of air in the form of air quality index and dispersion modeling.
5 Relate and analyze the pollution regulation on its scientific basis.
6 Justify the use of pollution control equipment and their design.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

1 Question paper will comprise of total six questions, each carrying 20 marks.
2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4 Only four questions need to be solved in total.
5 There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

Recommended Books:

1 Air Pollution: Rao. M. N. and Rao, H. V. N., Tata McGraw Hill Publication, New Delhi.
2 Environmental Pollution Control Engineering: Rao C.S., New Age International Publishers.
3 Noise Pollution: Agarwal S.K., APH Publishing Corporation.
4 Noise Pollution and Control Strategy: Singal S.P., Alpha Science International LTD.
5 Sewage disposal and Air pollution engineering: Garg, S.K., Khanna pbl.

Reference Books:

1 Air Pollution: Part A- Analysis and Part B-Prevention and Control: Ledbetter, J. O., Make Dekker Inc., New York.

2 Air Pollution: Wark and Warner, Harper and Row, New York.

3 Air Pollution Vol.1: Tripathi, A. K., Ashish Publication House, New Delhi.

4 Air Pollution Handbook: Magill, P. L.et al., McGraw Hill publication.

5 Air and Noise Pollution Control: Volume 1: Wang,L.K. and Pereira, N.C., Humana

6 Textbook of Noise Pollution and its Control: Bhatia S. C., Atlantic Publishers and Distributors, New Delhi.

7 Industrial Air Pollution Handbook: Parker, A., Tata McGraw Hills Publication.

8 Air Pollution: Henry Capeskins, McGraw Hill publication.

9 Environmental Noise Pollution: Noise Mapping, Public Health, and Policy,Enda Murphy and Eoin King.

10 Air Pollution: Wark and Warner, Harper and Row, New York.

11 Government of India's Publication of laws related to air pollution, Maharashtra Pollution Control Board's (MPCB) Publication of standards. IndianStandards relevant to Air Pollution Monitoring, Definitions, Standards.

12 Air Pollution Control Theory: Martin Crawford, McGraw Hill publication.

Semester-V

Course Code	Course Name	Credits
CEDLO5016	Department Level Optional Course - 1 Transportation Planning and Economics	03

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

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

Rationale

The ultimate aim of Transport planning is to generate alternatives for improving Transportation system to meet future demand and selecting the best alternative after proper evaluation. The Course concentrates on Transportation system planning, Public Transportation Planning, Parking planning, and economic analysis of Transportation projects. Basic purpose of transportation planning is focusing on what's the most efficient movement for people and goods around the world. Improving access to an area not only reduces congestion, but the accessibility attracts new residents and businesses ultimately helping economic development.

Objectives

1 To understand various urban development policies in India and to learn different planning surveys.

2 To analyze and plan future traffic flow using four stage modelling.

3 To understand the implementation of land use transport model in Urban area.

4 To carry out economic analyses for different transportation infrastructure projects.

5 To understand and plan Urban public Transportation system.

6 To plan and design Parking system for residential, commercial and other projects.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Urban Transportation Planning**		04
	1.1	Problems & factors in Transportation Planning, Development of Transportation Systems in India, Growth of Transport - Trends in Traffic - Imbalances in Transport System.	
	1.2	Urban growth mechanism – Urban morphology - Urbanization & travel demand - Urban development planning policy – NUTP - Urban transport projects - Urban transport problems in India	
	1.3	Urban travel patterns - Study area delineation- Zoning - Planning surveys - Urban activity system, Trip based and activity-based approach - Four stage travel demand modelling.	
2	**Four Stage Modelling**		10
	2.1	Trip generation analysis: trip classification, multiple regression analysis, category analysis	
	2.2	Trip distribution analysis: introduction, methods of trip distribution, uniform and average factor method, Fratar method, Furness method, the gravity model, opportunities model.	
	2.3	Modal split analysis: introduction, Modal split analysis modal split models.	
	2.4	Traffic Assignment: purpose of traffic assignment, Assignment techniques: All or nothing assignment, Multiple route assignment, Capacity restraint assignment, Diversion Curves.	
3	**Land Use Transport Modelling**		05
	3.1	Urban system components - Urban spatial structure – Accessibility - Location theory.	
	3.2	Land use models - Land use transport models, Lowry & Garin – Lowry models.	
4	**Transportation Economics**		10
	4.1	Economic evaluation of highway schemes, need for economic evaluation, cost and benefits of transportation projects	
	4.2	Basic principles of economic evaluation, Net present value method, benefit/cost ratio method, internal rate of return method. Vehicle operating costs.	
5	**Urban Public Transport Planning**		05
	5.1	Growth history – Urban growth & public transport needs - Modes of public transport and comparison - Public transport travel characteristics	
	5.2	Technology of bus, rail, rapid transit systems, and basic operating elements. Transit characteristics - Fleet size and capacity estimation.	
6	**Parking Planning and Design**		05

	6.1	Types of Parking's, Methods of surveys, Parking inventories, Parking Design	
	6.2	Planning of parking for residential and commercial buildings including shopping complex, malls and multiplex.	
		Total	**39**

Contribution to Outcome

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

1 Understand various Urban transport related terms and policies along with methods to carry out planning surveys.

2 Carry out trip generation, trip distribution, modal split and traffic assignment for planning of urban transport system.

3 Apply land use transport models at Urban area.

4 Carry out economic analysis of different Transport related Infrastructure projects by analyzing costs and benefits related to projects using NPV, IRR and B/C ratio method.

5 Estimate capacity of different public transportation modes in Urban area and to plan and schedule the same based on fleet size.

6 Plan and design Parking facility at Urban area.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only four questions need to be solved in total.

Recommended Books:

1 Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2002.

2 IRC: SP: 30-1993., Manual on Economic Evaluation of Highway Projects in India.

3 Sarkar P K., Maitri V.,Economics in Highway and Transportation Planning, Standard Publisher, New Delhi, 2010.

4 K.S. Ramegauda, Urban and Regional Planning, Mysore University Publication.

5 Ceder, A.,Public Transit Planning and Operation: Theory, Modeling and Practice, B-H Elsevier Ltd., MA, 2007.

6 IRC:SP:12-2015, Guidelines for Parking Facilities in Urban Roads

Reference Books:

1 Khisty C J., Lall B.Kent, Transportation Engineering – An Introduction, Prentice-Hall, NJ, 2005

2 Ortuzar, J. D., Willumsen, L.G., Modeling Transport, John Wiley & Sons, 1994

3 Papacostas C.S. and Prevedouros, P.D., Transportation Engineering & Planning, PHI, New Delhi,2002

4 Hutchinson B.G., Principles of Urban Transportation System Planning, Mc-Graw Hill, 1974.

Semester-V

Course Code	Course Name	Credits
CEDLO5017	Department Level Optional Course – 1 Advanced Concrete Technology	03

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

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

Rationale

Basic concept of concrete technology is essential for civil engineering students to execute the civil engineering projects as per the standard laid down time to time. Advancements in concrete technology is the backbone of infrastructure of civil engineering field. This course provides necessary knowledge about various concreting operations and testing operations during and after construction. This course is intended for gaining knowledge about the properties of materials, especially concrete and to maintain quality in construction projects. This course will also provide knowledge to the students about the criteria to be remembered during the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing.

Objectives

1 To understand the various properties and tests of materials used in concrete along with the rheology of fresh concrete.

2 To study the different procedures for testing hardened concrete, its compositions and quality of in place concrete.

3 To understand the concept of durability and cracking in concrete. To also understand the significance and parameters of concreting under extreme environment and conditions.

4 To understand the concept and optimization of the mix design of concrete by various codes.

5 To study the various constituents, properties, significance and applications of special concrete.

6 To study the quality of concrete and check the acceptance criteria.

Detailed Syllabus			
Module	**Course Module / Contents**		**Periods**
1	**Constituents and Properties Of Concrete**		**08**
	1.1	Introduction of cement and water: Chemical composition of OPC, hydration, chemistry of cement, cement testing, water requirement for hydration, water quality for concrete and water quality test.	
	1.2	Aggregates: Types of aggregate (natural, synthetic, recycled), required characteristics of aggregates for concrete, introduction to gradation of aggregates, standard grading curve and gap grading.	
	1.3	Chemical admixture: Introduction to accelerators, retarders, plasticizers, super plasticizers, viscosity modifying admixtures, water proofers, miscellaneous admixtures.	
	1.4	Mineral admixture: Introduction, composition of mineral admixture, fly ash and its type, silica fume, ground granulated blast furnace slag and others. Effects of mineral admixture on fresh and hardened concrete properties.	
	1.5	Properties of fresh concrete: Introduction to properties of fresh concrete, w/c ratio, w/b ratio, gel space ratio, maturity concept, aggregate cement bond strength, pumping of concrete.	
	1.6	Rheological models of fresh concrete: Introduction, simple flow test, rheological models and test methods, factors affecting rheological properties of concrete and effect of rheological properties on different types of concrete.	
2	**Testing of Concrete**		**05**
	2.1	Introduction to testing of hardened concrete - compression, tension, and flexure. Methods of testing (destructive, semi destructive, non-destructive).	
	2.2	Properties of hardened concrete: Factors influencing strength, importance of end effects in compression testing, tensile strength of concrete (split and flexural), relationship between compressive and tensile strength.	
	2.3	Advanced non-destructive evaluation: Ground penetration radar, probe test penetration, pull out/off, break off method, stress wave propagation method, electrical / magnetic methods, infrared thermography, and core test.	
3	**Durability of Concrete**		**10**
	3.1	Introduction to durability and permeability: Transport mechanism of fluids and gases in concrete, role of w/c and admixture on durability. Design of durability using performance specification.	
	3.2	Corrosion and carbonation: Introduction to corrosion of reinforcement in concrete, factors influencing corrosion, damages preventive measures of corrosion, tests for existing structures and remedial measures of corrosion, introduction and measurement of depth of carbonation.	
	3.3	Concrete structures in special environment: Frost action, fire or	

		high temperature, chemical attack and aggressive environment (sulphate attack, chloride attack, acid attack in sewers, sea water attack), alkali aggregate reaction (alkali silica and carbonate reaction).	
	3.4	Concreting under extreme weather: Hot and cold weather concreting, underwater concreting.	
4	**Concrete Mixture Design**		**07**
	4.1	Design of concrete mixes by IS 10262 (latest edition) Method – with and without fly ash, super plasticizer, effect of pumping of concrete on mixture design.	
	4.2	Design of concrete mixes by American Concrete Institute (ACI) Method – Air and non-air entrained concrete.	
	4.3	Design of concrete mixes by Department of Environment (DoE) Method.	
	4.4	Design of concrete mixes by Road note 4 Method.	
	4.5	Design of high strength concrete mixes using ACI 211.4R - 93 Method.	
5	**Special Concretes**		**06**
	5.1	Light weight concrete and ultra-light weight concrete: Types and properties of light weight aggregates, factors influencing the strength and density of light weight aggregate concrete, properties of light weight aggregate concrete. Introduction to other light weight concrete – Cellular and foamed concrete. (01).	
	5.2	High performance concrete: Methods for achieving high performance concrete, requirements for high performance characteristics, material selection, advantages and applications.	
	5.3	Self-compacting concrete (SCC): Materials for SCC, comparison of traditional and SCC constituents, requirements for SCC, initial mix compositions, production and placing of SCC, fresh concrete tests for SCC.	
	5.4	Fiber Reinforced Concrete (FRC): Study of different fibers (metallic fiber, polymeric fibers, carbon fibers, glass fibers, naturally occurring fibers) in concrete with respect to volume fraction, orientation and aspect ratio, physical and mechanical properties - steel and polypropylene fiber reinforced concrete. Applications of steel and polypropylene fibers reinforced concrete.	
	5.5	Introduction to other special concrete – Vacuum concrete, waste material-based concrete, shotcrete, roller compacted, mass concrete.	
6	**Quality Control (QC)**		**03**
	6.1	Introduction: Statistical QC, quality factors, control charts.	
	6.2	Acceptance criteria according to Indian standards: Strength of concrete (site and laboratory)	
		Total	**39**

Contribution to Outcome

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

1. To use the various concrete materials and demonstrate the fresh properties of concrete.
2. To perform different testing methods of concrete.
3. To describe the durability of concrete and apply the knowledge of durability in extreme weather concreting.
4. To design the concrete mix for field application by different methods.
5. To explain the various properties of special concrete.
6. To discuss the quality of concrete and explain the acceptance criteria.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

1. Concrete Technology: A. R. Shanthakumar, Oxford University Press, New Delhi, 2007.
2. Concrete Technology Theory and Practice: Shetty M.S., S. Chand.
3. Properties of concrete: Neville, Isaac Pitman, London.
4. Concrete Technology: Gambhir M.L., Tata McGraw Hill, New Delhi.
5. Concrete Technology: Neville A.M. & Brooks. J. J., ELBS-Longman, Pearson Education Ltd.
6. Relevant I.S. codes: Bureau of Indian standard and ACI code.
7. Design of concrete mixes by N Krishna Raju (Latest Edition), CBS Publishers and Distributers Pvt. Ltd.

Reference Books:

1 Fibre Reinforced Cementitious Composites: Arnon Bentur and Sidney Mindess, Modern Concrete Technology Series, Tylor and Francis.

2 Concrete- Microstructures, Properties and Materials: P. Kumar Mehta and Paulo J. M. Monteiro, Indian Edition, Indian Concrete Institute, Chennai, 1999

3 Special Publication of ACI on Polymer concrete and FRC.

4 Concrete Technology: D.F. Orchardi, Wiley, 1962.

5 www.theconcreteportal.com

Semester-V

Course Code	Course Name	Credits
CEL501	Theory of Reinforced Concrete Structures (Lab)	01

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

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

Course Objectives:

1. To develop a clear understanding of design philosophy amongst the students for the design of reinforced concrete structures using working stress method (WSM) and limit state method (LSM).
2. To study various clauses of IS: 456-2000 and their significance in the RCC design.
3. To apply various concepts of LSM in the analysis and design of beams, slabs and columns.
4. To study the concept of Serviceability and Durability for deflection and crack width calculation in RCC structures.
5. To develop the concept of design using design charts and curves for columns subjected to axial load and moment.
6. To study the concept of reinforced concrete footing design subjected to axial load and moment.

Course Outcomes:

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

1. Understand the fundamentals of WSM and LSM.
2. Apply various clauses specified in IS: 456-2000 for designing structural members with safety and economy.
3. Understand the use of readymade design charts and curves from Special Publications of Bureau of Indian Standards.
4. Analyze and design various reinforced concrete elements such as beam, slab, column, footings using the concept of Limit State Method.

List of Tutorials and Assignments		
Week (Activity)	**Detailed Content**	**Hours**
1st Week (Tutorial)	Analysis and Design of Singly and Doubly Reinforced RCC beam using WSM (Numericals Based on this module will be solved in tutorial class)	02
2nd Week (Assignment)	Analysis and Design of Singly and Doubly reinforced RCC beam using WSM or any one activity from below: Solve set of Questions given by the course instructor. Write a report on provisions in IS 456 2000 related to the design of beams A comparative study consisting of advantages and disadvantages of WSM and LSM	02
3rd Week (Tutorial)	Analysis and Design of Singly and Doubly Reinforced RCC beam using LSM. (Numericals Based on this module will be solved in tutorial class)	02
4th Week (Assignment)	Analysis and Design of Singly and Doubly Reinforced RCC beam using LSM. Or any one activity from below: Solve set of Questions given by the course instructor. Study of IS 456 2000 provisions on Limit state of collapse: Flexure.	02
5th Week (Tutorial)	Analysis and Design of Flanged beams for Flexure using LSM. Design of RCC beams in shear, bond, and torsion. (Numericals Based on this module will be solved in tutorial class)	02
6th Week (Assignment)	Analysis and Design of Flanged beams for Flexure using LSM. Or any one activity from below: Design of RCC beams in shear, bond, and torsion. Solve set of Questions given by the course instructor. Study of IS 456 2000 provisions on Limit state of collapse- Shear, Bond and Torsion.	02
7th Week (Tutorial)	Design of Simply supported One-way and Two-way slabs as per IS: 456-2000 (Numericals Based on this module will be solved in tutorial class)	02
8th Week (Assignment)	Design of Simply supported One-way and Two-way slabs as per IS: 456-2000. Or any one activity from below: Solve set of Questions given by the course instructor. Study of IS: 456-2000 provisions on Design of RCC slabs.	02
9th Week (Tutorial)	Analysis and Design of Columns loaded Axially, Uni-axially, and Bi-axially, using LSM. (Numericals Based on this module will be solved in tutorial class)	02
10th Week (Assignment)	Analysis and Design of Columns loaded Axially, Uni-axially, and Bi-axially, using LSM. or any one activity from below: Solve set of Questions given by the course instructor. Studying the development of interactive curves and their use in column design.	02

	Study of IS: 456-2000 Provisions for Limit State of Collapse – Compression	
11th Week (Tutorial)	Design of Isolated square and rectangular footings subjected to axial load and moment. (Numericals Based on this module will be solved in tutorial class)	02
12th Week (Assignment)	Design of Isolated Square and rectangular footings subjected to axial load and moment. or any one activity from below: Solve set of Questions given by the course instructor. Study of IS: 456-2000 provisions related to design of RCC foundations. Report or presentation on Significance and Design of different types of RCC Foundations by various groups of students.	02
13th Week	Viva – Voce Examination	02

Assessment:

- **Term Work**

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	10 Marks
Assignments	:	10 Marks
Attendance	:	05 Marks

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

- **End Semester Oral Examination**

Oral examination will be based on entire syllabus.

- **Recommended books:**

Design of Reinforced Concrete Structures: Dayaratnam, P; Oxford and IBH.

Limit State Design of Reinforced Concrete: Jain A. K, Nemchand and Bros., Roorkee

Limit State Design of Reinforced Concrete: Shah and Karve, Structure Publications, Pune.

Ultimate Strength Design for Structural Concrete: Arthur, P. D. and Ramakrishnan, V., Wheeler and Co. Pvt. Ltd.

Reinforced Concrete: H.J. Shah, Charotar Publishers, Anand.

Fundamentals of Reinforced Concrete: Sinha & Roy, S. Chand and Co. Ltd.

Illustrated Reinforced Concrete Design: Dr. V. L. Shah and Dr. S. R. Karve, Structure Publications, Pune.

Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A, John Wiley (2007), 7th Edition.

Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.

Semester-V

Course Code	Course Name	Credits
CEL502	Applied Hydraulics (Lab)	01

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

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

Course Objectives:

1 To describe the concepts of fluid dynamics and its applications.

2 To exemplify the fundamentals of impulse momentum principle and explain the working of various hydraulic machines.

3 To classify the uniform and non-uniform flow in open channel.

Course Outcomes:

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

1 Evaluate the efficiencies and discuss the working of various pumps and turbines.

2 Apply impulse momentum principle to hydraulic machines.

3 Determine the rate of flow through open channel.

4 Generate and evaluate Gradually varied flow (GVF) and Rapid varied Flow (RVF) in open channel flow.

5 Compute the Chezy's Constant through tilting flume.

List of Experiments (Minimum Six)		
Module	**Detailed Content**	**Lab Session / Hr.**
1	Impact of jet, flat plate, inclined plate, curved vanes.	02
2	Performance of Pelton turbine.	02
3	Performance of Francis Turbine.	02
4	Performance of Kaplan Turbine.	02
5	Performance of Centrifugal pumps.	02
6	Chezy's roughness factor.	02
7	Specific energy.	02
8	Hydraulic Jump.	02
9	Calibration of Broad crested weir/Venturi flume.	02

Assessment:

- **Term Work**

The term work shall comprise of the neatly written report based on the afore-mentioned experiments and assignments. The assignments shall comprise of the minimum 20 problems covering the entire syllabus divided properly module wise. The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	10 Marks
Assignments	:	10 Marks
Attendance	:	05 Marks

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

- **End Semester Oral Examination**

Pair of Internal and External Examiner should conduct oral examination.

Reference Books:

1 Fluid Mechanics and Hydraulic Machines: R. K. Rajput, S. Chand and Company.

2 Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi.

3 Hydraulics Fluid Mechanics and Fluid Machines: S. Ramamrutham, Dhanpat Rai Publishing Company (P) Ltd-New Delhi.

4 Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.

5 Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538.

6 Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons.

7 Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

Semester-V

Course Code	Course Name	Credits
CEL503	Geotechnical Engineering – I (Lab)	01

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

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

Course Objectives:

1	Determination of moisture content, specific gravity of soil solids and in-situ field density of soils as well as field identification of fine-grained soils
2	To determine the grain size distribution of soils and consistency or Atterberg limits of fine-grained soils
3	To determine coefficient of permeability of soils in laboratory
4	To determine compaction characteristics of soils in laboratory
5	To determine the density index (relative density) of cohesionless soil
6	To determine field SPT ‘N’ value by Standard Penetration Test

Course Outcomes:

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

1	Determine the physical and engineering properties of soil
2	Determine the plasticity characteristics of soil
3	Carry out sieve analysis of soil, plot grain size distribution curve and determine the IS classification of soil
4	Determine coefficient of permeability of soils
5	Determine the compaction characteristics of soils
6	Compute the field SPT ‘N’ value and prepare the bore log

List of Experiments (Minimum ten)		
Module	**Detailed Content**	**Lab Session / Hr.**
1	Determination of natural moisture content of soil using oven drying method Following other methods to find moisture content shall be explained briefly: a) Pycnometer method b) Sand bath method c) Alcohol method d) Torsional balance method e) Moisture meter f) Radio activity method	02
2	Specific gravity of soil grains by density bottle method or Pycnometer method	02
3	Field density using core cutter method	02
4	Field density using sand replacement method	02
5	Field identification of fine-grained soils	02
6	Grain size distribution of coarse-grained portions (gravel and sand) of soil by sieve analysis	02
7	Grain size distribution of fine portions (silt and clay) of the soil by Hydrometer analysis	02
8	Determination of liquid (Casagrande method), plastic and shrinkage limits	02
9	Determination of liquid limit by cone penetrometer method	02
10	Determination of co-efficient of permeability using constant head method	02
11	Determination of co-efficient of permeability using falling head method	02
12	Compaction test, IS light compaction test/ Standard Proctor test	02
13	Compaction test, IS heavy compaction test/ Modified Proctor test	02
14	Relative density (or, density index) test	02
15	Standard penetration test	02

Assessment:

- **Term Work**

a) The term work shall be comprised of the neatly written reports based on the experiments performed in the laboratory, assignments, attendance and case study.
b) The assignments shall be given covering the entire syllabus in such a way that the students would attempt at least two problems on each module/ sub-module.
c) Students (5 students max. in a group) should perform a case study on Forensic Investigation for Geotechnical Failures/or, Geo environmental Engineering and must submit a report or power

point presentation on the same. The questions related to this concept shall not be asked in the theory examination. However, it shall be treated as a part of term work submission.

Distribution of Term-work Marks

The marks of the term work shall be judiciously awarded depending upon the quality of the laboratory works, assignments, attendance and case study. The final certification acceptance of term work warrants the satisfactory and appropriate completion of laboratory work, assignments and case study with the minimum passing marks by the students. The following weightage of marks shall be given for different components of the term-work.:

Laboratory Work	:	12 Marks
Case study	:	03 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

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

- **End Semester Oral Examination**

The oral examination shall be based upon the entire theory and laboratory syllabus.

Reference Books:

1 SCI/SCOPUS Indexed Refereed International Journals (For Case Studies)

2 Relevant Indian Standard Specifications Codes, BIS Publications, New Delhi.

3 Departmental Laboratory Manual

4 Standard Geotechnical Engineering Handbook

5 NPTEL Video lectures on Practical.

Semester-V

Course Code	Course Name	Credits
CEL504	Transportation Engineering (Lab)	01

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

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

Course Objective:

1 To determine Penetration grade and Viscosity grade of bitumen.

2 To find the Softening point and Ductility value of bitumen.

3 To determine Impact, Abrasion and Crushing value of aggregate.

4 To carry out shape test on aggregates.

5 To carry out Classified volume study and plot speed profile at mid-block section.

Course Outcomes:

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

1 Classify Bitumen on basis of Penetration and Viscosity grade.

2 Select Bitumen as per suitability on basis of Softening point and Ductility value.

3 Determine suitability of aggregate on basis of Impact value, Abrasion value and Crushing value.

4 Differentiate Elongated and Flaky aggregates on basis of Shape test.

5 Carry out Classified volume study at mid-block section of road.

6 Plot speed profile curve (S-Curve) at mid-block section.

List of Experiments (Minimum Eight)		
Module	**Detailed Content**	**Lab Session / Hr.**
1	Penetration Test on Bitumen.	02
2	Viscosity Test on Bitumen.	02
3	Softening Point Test on Bitumen	02
4	Ductility Test on Bitumen	02
5	Determination of Aggregate Impact Value	02
6	Determination of Aggregate Crushing Value	02
7	Determination of Abrasion Value of Road Aggregate	02
8	Shape Test of Aggregate	02
9	Classified Volume count at mid-block section	02
10	Speed profile study at mid-block section	02

Assessment:

- **Term Work**

Including Laboratory Work Survey project report and Assignments, Distribution of marks for Term Work shall be as follows:

Laboratory Work and Traffic Survey	:	10 Marks
Assignments	:	10 Marks
Attendance	:	05 Marks

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

- **End Semester Oral Examination**

Oral exam will be based on experiments performed, traffic survey carried out and theory syllabus.

Reference Books:

1 Highway Engineering: Khanna, S.K. and Justo, C. E. G.;Nem Chand and Bros., Roorkee.

2 Principles, Practice and Design of Highway Engineering (Including Airport Engineering)" Sharma, S.K.; S. Chand and Company Pvt. Ltd., New Delhi.

3 Highway Material and Pavement Testing: Dr. S. K. Khanna, Dr. C. E. G. Justo and Dr. A. Veeraragavan. Nem Chand and Bros., Roorkee, India.

4 Traffic Engineering and Transport Planning: Kadiyali, L.R., Khanna Publishers, Delhi

5 Principles and Practice of Highway Engineering: Kadiyali, L. R.; Khanna Publsihers, Delhi.

6 Relevant specifications of MORTH and relevant IRC codes.

Semester-V

Course Code	Course Name	Credits
CEL505	Professional Communication and Ethics-II	02

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
---	02*+02	-	-	02	-	02

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

Course Rationale

This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.

Course Objectives

1 Discern and develop an effective style of writing important technical/business documents.

2 Investigate possible resources and plan a successful job campaign.

3 Understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.

4 Develop creative and impactful presentation skills.

5 Analyze personal traits, interests, values, aptitudes and skills.

6 Understand the importance of integrity and develop a personal code of ethics.

Course Outcomes

Learner will be able to

1 Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.

2 Strategize their personal and professional skills to build a professional image and meet the demands of the industry.

3 Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.

4 Deliver persuasive and professional presentations.

5 Develop creative thinking and interpersonal skills required for effective professional communication.

6 Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Advanced Technical Writing: Project/ Problem Based Learning (PBL)**		06
	1.1	**Purpose and Classification of Reports, Classification on the basis of:** Subject Matter (Technology, Accounting, Finance, Marketing, etc.); Time Interval (Periodic, One-time, Special); Function (Informational, Analytical, etc.); Physical Factors (Memorandum, Letter, Short & Long)	
	1.2	**Parts of a Long Formal Report** Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter)	
	1.3	**Language and Style of Reports**: Tense, Person & Voice of Reports, Numbering Style of Chapters, Sections, Figures, Tables and Equations, Referencing Styles in APA & MLA Format, Proofreading through Plagiarism Checkers	
	1.4	**Definition, Purpose & Types of Proposals:** Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals)	
	1.5	**Parts of a Proposal** Elements: Scope and Limitations, Conclusion	
	1.6	**Technical Paper Writing**: Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References), Language and Formatting, Referencing in IEEE Format	
2	**Employment Skills**		06
	2.1	**Cover Letter & Resume:** Parts and Content of a Cover Letter, Difference between Bio-data, Resume & CV, Essential Parts of a Resume, Types of Resume (Chronological, Functional & Combination)	
	2.2	**Statement of Purpose:** Importance of SOP, Tips for Writing an Effective SOP	
	2.3	**Verbal Aptitude Test:** Modelled on CAT, GRE, GMAT exams	
	2.4	**Group Discussions:** Purpose of a GD, Parameters of Evaluating a GD, Types of GDs (Normal, Case-based & Role Plays), GD Etiquettes	
	2.5	**Personal Interviews:** Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioral, Problem Solving & Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	

3	**Business Meetings**		**02**
	3.1	**Conducting Business Meetings:** Types of Meetings, Roles and Responsibilities of Chairperson, Secretary and Members, Meeting Etiquette	
	3.2	**Documentation**: Notice, Agenda, Minutes	
4	**Technical/ Business Presentations**		**02**
	4.1	**Effective Presentation Strategies**: Defining Purpose, Analysing Audience, Location and Event, Gathering, Selecting & Arranging Material, structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation, Platform Skills	
	4.2	**Group Presentations**: Sharing Responsibility in a Team, Building the contents and visuals together, Transition Phases	
5	**Interpersonal Skills**		**08**
	5.1	**Interpersonal Skills**: Emotional Intelligence, Leadership & Motivation, Conflict Management & Negotiation, Time Management, Assertiveness, Decision Making	
	5.2	**Start-up Skills:** Financial Literacy, Risk Assessment, Data Analysis (e.g., Consumer Behaviour, Market Trends, etc.)	
6	**Corporate Ethics**		**02**
	6.1	**Intellectual Property Rights:** Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications, Integrated Circuits, Trade Secrets (Undisclosed Information)	
	6.2	**Case Studies:** Cases related to Business/ Corporate Ethics	
		Total	**26**

List of Assignments for Term Work

In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.

1 Cover Letter and Resume

2 Short Proposal

3 Meeting Documentation

4 Writing a Technical Paper/ Analysing a Published Technical Paper

5 Writing a SOP

6 IPR

7 Interpersonal Skills

8 Aptitude test (Verbal Ability)

Note:

- The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
- The group size for the final report presentation should not be less than 5 students and not to exceed more than 7 students.
- There will be an end–semester presentation based on the book report.

Assessment:

- **Term Work**

Term work shall consist of minimum 8 experiments.

Assignments	:	10 Marks
Presentation Slides	:	05 Marks
Book Report (Hard Copy)	:	05 Marks
Attendance	:	05 Marks

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted to: 75%- 80%: 03 Marks; 81%- 90%: 04 Marks; 91% onwards: 05 Marks.
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

- **Internal Oral**

Oral Examination will be based on a GD & the Project/Book Report presentation

Group Discussion	:	10 Marks
Individual Presentation	:	10 Marks
Group Dynamics	:	05 Marks

Recommended Books:

1 Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/ Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill.
2 Bovée, C. L., &Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.
3 Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.
4 Masters, L. A., Wallace, H. R., & Harwood, L. (2011). Personal development for life and work. Mason: South-Western Cengage Learning.
5 Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational behaviour. Harlow, England: Pearson.
6 Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7 Archana Ram (2018) Place Mentor, Tests of Aptitude for Placement Readiness. Oxford University Press
8 Sanjay Kumar & Pushp Lata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Semester-V

Course Code	Course Name	Credits
CEM501	Mini Project -2A	2

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	04	-	-	2	-	2

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

Rationale

From primitive habitats of early years to modern buildings, the civil engineering industry's growth has been needing based and society centric. Civil engineers deal with many challenges on daily basis that most people do not have any idea. Mumbai University proposed Mini projects in the syllabus so that the budding civil engineers can connect with the world outside their books and have the idea of future course. The Mini project should actually provide solution to a typical problem after a brainstorming and in a stipulated period. The competitions ahead will give students the experience of the civil engineering industry's real-world problems and make students brainstorm ideas, learn, and explore the civil engineering industry.

Course Objectives:

1	To recognize societal problems and convert them into a problem statement by understanding of facts and ideas in a group activity.
2	To deal with new problems and situations by applying acquired knowledge, facts, techniques and rules in a different way.
3	To examine and break information into parts, by analyzing motives or causes.
4	To learn evaluating information, validity of ideas and work based on a set of criteria.
5	To create solutions by compiling information together in a different way.
6	To design model by combining elements in a new pattern or proposing new solutions.

Course Outcomes:	
At the end of the course, learner will be able to:	
1	Identify problems based on societal /research needs and formulate a solution strategy.
2	Apply fundamentals to develop solutions to solve societal problems in a group
3	Analyze the specific need, formulate the problem and deduce the interdisciplinary approaches, software-based solutions and computer applications.
4	Develop systematic flow chart, evaluate inter disciplinary practices, devices, available software, estimate and recommend possible solutions.
5	Draw the proper inferences from available results through theoretical/ experimental/ simulations and assemble physical systems.
6	Create devises or design a computer program or develop computer application.

- **Guidelines for Mini Project -2A**

  Expected outcome is hardware based, "A Working Model."

  Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.

  Students should find 'List of Mini project – 2A problems' in University web portal www.mu.ac.in, and in consultation with faculty supervisor/ head of department/ internal committee of faculties select the title.

  Students shall submit implementation plan in the form of Gant/ PERT/ CPM chart, which will cover weekly activity of mini project.

  A log book to be prepared by each group, wherein group can record weekly work progress, guide/ supervisor can verify and record notes/ comments.

  Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

  Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

  Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

  The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

  With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that Students come out with original solution.

  However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/ modifications or a completely new project idea in even semester. This policy can be adopted on case-by-case basis.

List of approved problems for Mini Project -2A:	
H501:	Construction of Model showing New application of alternative materials and byproducts of different industries for Durability and sustainability.
H502:	Construction of Model/ device for Smart Traffic Management System Using Internet of Things
H503:	IOT based smart device for traffic signal monitoring system using vehicle Count.
H504:	Mini Project on Construction of Model showing New application of use of Fly Ash in Civil Engineering works.
H505:	Mini Project on specimen of Modified Concrete Pavements (using unconventional, recycled or waste product)
H506:	Novel device for Base isolation system for multistoried building
H507:	Mini project on specimen of light transmitting concrete.
H508:	Model of Novel Seismic isolation devices for bridge structures.
H509:	Novel Applications of Bamboo as a building material specimen.
H510:	Development of device using sensors for deflection of girders. Beams, slabs or bridges.
H511:	Development of device using sensors for detection of fracture in Railway tracks.
H512:	Mini project on specimen of Bubble deck slab.
H513:	Construction of specimen of GFRG panels as walls in buildings instead of conventional walls.
H514:	Construction of specimen of Agro waste reinforced panels as walls in buildings instead of conventional walls.
H515:	Construction of specimen of unconventional panels as walls in buildings instead of conventional walls.
H516:	Construction of specimen of Ferro cement Slab as a replacement to RCC slab.
H517:	Construction of specimen of No Fines Concrete or porous Concrete and its applications.
H518:	Construction of Model of Novel Soil Stability technique to prevent landslides.
H519:	Construction of Model of a dwelling unit (house) in rural area.
H520:	Typical design of Model for construction of toilets in rural India.
H521:	Construction of Model for Typical applications of Ferro concrete.
H522:	Construction of Model of road paths with locally sourced materials in villages.
H523:	Construction of Model showing Typical application of Prestressed concrete.
H524:	Construction of Model showing Typical application of fiber reinforced concrete.

(This is tentative list, this list will be continuously updated by contributions from faculty, industry and alumni.)

Guidelines for Assessment of Mini Project:

- **Term Work**

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below:

Marks awarded by guide/supervisor based on log book	:	10 Marks
Marks awarded by review committee	:	10 Marks
Quality of Project report	:	5 Marks

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

- **One-year project:**

  Only if a project is very demanding it will be considered for 'One Year Project'. Subject to approval by the Head of the department.

  Outcome shall be a 'Hardware and a software based' solution

  There shall also a 'technical paper' to be presented in conference/published in journal (UGC approved) or student's competition.

  In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.

  First shall be for finalization of problem

  Second shall be on finalization of proposed solution of problem.

  In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.

  First review is based on readiness of building working prototype to be conducted.

  Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

- **Half-year project:**

  In this case in one semester students' group shall complete project in all aspects including

  Identification of need/problem

  Proposed final solution

  Procurement of components/systems

  Building prototype and testing

  Two reviews will be conducted for continuous assessment,

  First shall be for finalization of problem and proposed solution.

  Second shall be for implementation and testing of solution.

- **Assessment criteria of Mini Project:**

  Mini Project shall be assessed based on following criteria:

  Quality of survey/ need identification

  Clarity of Problem definition based on need.

  Innovativeness in solutions

  Feasibility of proposed problem solutions and selection of best solution

  Cost effectiveness

  Societal impact

  Innovativeness

  Cost effectiveness and Societal impact

  Full functioning of working model as per stated requirements

  Effective use of skill sets

  Effective use of standard engineering norms

  Contribution of an individual as member or leader

  Clarity in written and oral communication

  In one year, project, first semester evaluation may be based on first six criteria and remaining may be used for second semester evaluation of performance of students in mini project.
  In case of half year project all criteria in generic may be considered for evaluation of performance of students in mini project.

- **Guidelines for Assessment of Mini Project Practical/Oral Examination:**

  Report should be prepared as per the guidelines issued by the University of Mumbai.

  Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years and approved by head of Institution.
  Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

- **Mini Project shall be assessed based on following points:**

  Quality of problem and Clarity

  Innovativeness in solutions

  Cost effectiveness and Societal impact

  Full functioning of working model as per stated requirements

  Effective use of skill sets

  Effective use of standard engineering norms

  Contribution of an individuals as member or leader

  Clarity in written and oral communication

Semester VI

Semester-VI

Course Code	Course Name	Credits
CEC601	Design and Drawing of Steel Structures	03

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

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	
Test-I	Test-II	Average						
20	20	20	80	4 Hours	-	-	-	100

Rationale

Steel structures are preferred due to their higher strength, speed of construction and aesthetic view. Civil Engineers must have knowledge of designing and detailing of steel structures to make structures safe and serviceable during its life span. I.S. code specifying the use of Limit State design philosophy for design of steel structures and its various components. This course is designed to provide basic knowledge of design and detailing of steel structures.

Objectives

1 To make students familiar with behavior of steel structure and their components under the action of various loads.
2 To train the students for effective use of IS codes, design tables and aids in analyzing and designing the steel structures by limit state method.
3 To help students design connections of steel members.
4 To equip students with aspects required for designing tension member, compression members and column bases.
5 To equip students with aspects required for designing of flexural members.
6 To aid students in designing steel trusses.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction**		03
	1.1	Types of steel structures, Properties of Structural Steel, Indian Standard Specifications and Sections, Advantages and limitations of WSM, permissible stresses in WSM. Introduction to Limit State Design, partial safety factors for load and resistance, design load combinations, section classification such as plastic, compact, semi-compact and slender.	
2	**Design of Bolted And Welded Connections**		06
	2.1	Design of bolted and welded connections for axial force, beam to beam and beam to column connections. Framed, stiffened and unstiffened seat connections, bracket connections.	
3	**Design of Tension Members**		04
	3.1	Introduction, types of tension members, net area calculation.	
	3.2	Design strength due to yielding, rupture and block shear.	
	3.3	Design of tension members with welded and bolted end connection using single angle section & double angle section.	
4	**Design of Compression Members and Column Bases**		11
	4.1	Introduction, types of compression members, classification of cross sections, types of buckling, effective length of column and slenderness ratio, buckling curves, design of compression members as struts using single angle sections & double angle section.	
	4.2	Design of axially loaded column using rolled steel sections, design of built-up column, laced and battened Columns.	
	4.3	Design of slab bases & gusseted base.	
5	**Design of Flexural Members**		11
	5.1	Design strength in bending, effective length, Lateral torsion buckling behavior of unrestrained beams, design of single rolled section with or without flange plates, design strength of laterally supported beams, low and high shear, design strength of laterally unsupported beams, web buckling, web crippling, shear lag effect and deflection.	
	5.2	Design of welded plate girder: proportioning of web and flanges, flange plate curtailment	
6	**Design of Truss**		04
	6.1	Design of determinate truss. Calculation of dead load, live load and wind load acting on truss. Load combinations and calculation of internal forces. Design and detailing of members. Support detailing. Design of angle section purlin.	
		Total	39

Contribution to Outcome

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

1 Use the knowledge of Limit State Design philosophy as applied to steel structures. IS 800 code clauses
2 Design bolted and welded connections.
3 Design members subjected to axial tension.
4 Design compression members, Built-up columns and column bases.
5 Design members subjected to bending moment, shear force etc.
6 Estimate design loads as per IS 875 for roof truss and design the Steel roof truss.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

1 Question paper will comprise of total Five questions. $\{(\mathbf{32} + (\mathbf{4} \times \mathbf{16})\}$
2 Question 1 will be compulsory carrying 32 marks and should be based on steel design project.
3 Remaining questions will be carrying 4×16 marks, mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. Only three questions carrying 16 marks need to be solved.
4 Total Four questions need to be solved. (32+16+16+16)
5 In end semester examination, students will write answers in answer booklet and draw sketches on half imperial drawing sheet.
6 **Use of relevant IS codes shall be allowed in the examination**

Recommended Books:

1 Design of Steel Structure by N. Subramanian, Oxford University Press, New Delhi.
2 Limit state design of steel structures by S. K. Duggal, McGraw Hill Education (India) Pvt. Limited, New Delhi.
3 Design of steel structure by Limit State Method as per IS: 800 - 2007 by Bhavikatti S. S., I.K. International Publishing House, New Delhi.
4 Design of Steel Structures by K. S. Sai Ram, Pearson Education, New Delhi.
5 Limit state design of steel structures as per IS 800/2007. by S. Kanthimathinathan. I.K. International Publishing House, New Delhi.
6 Relevant Indian Specifications, Bureau of Indian Standards, New Delhi
7 Limit state design of steel structure by Dr. V.L. Shah and Gore, Structure publication Pvt. Pune.

Reference Books:

1 Design of Steel Structure by Allen Williams

2 Practical Design of Steel Structure by Karuna Moy Ghosh, Whittles Publishing

3 Structural design and drawing by D. Krishnamurthy, CBS Publishers, New Delhi.

4 Teaching Resources Material for steel structures by INSDAG Kolkata.

Semester-VI

Course Code	Course Name	Credits
CEC602	Water Resources Engineering	03

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

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

Rationale

India is an agricultural country where majority of population lives in villages so agricultural industry is the backbone of Indian economy. Being a tropical country with large temporal and spatial variation of rainfall and availability of rainfall only for three to four months, irrigation is strongly needed in India. To satisfy this need, enhancing the irrigation facilities in the country is required. This course provides necessary knowledge and information about various irrigation methods as well as water requirements of crops, hydrologic processes, control level fixation of dams and reservoirs and hydraulics of wells. In addition to this, it provides necessary knowledge about analysis and design of gravity dams and earthen dams, different silt theories related to irrigation channels, detailed classification of canal head-works and its distribution system and finally discusses about different canal structures and cross drainage works.

Objectives

1 To study different irrigation engineering methods and water requirement of crops.

2 To study hydrological cycle, its elements and plotting of hydrographs.

3 To study and calculate discharge from aquifers.

4 To study control level fixation for reservoir, Dams i.e., gravity dam, its various components and analysis and suitable conditions of earthen dam and its seepage analysis.

5 To study importance of silt theories and its design considerations.

6 To study Canal headwork, its distribution system and design of canal structures.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Irrigation Methods and Water Requirement of Crops**		07
	1.1	National water policy. Introduction to irrigation and need of irrigation, Benefits of irrigation and ill effects of irrigation, types of Irrigation Projects: minor, medium and major irrigation projects and National water policy.	
	1.2	Methods of Irrigation Systems: Surface irrigation and different techniques of water distribution for surface irrigation, Subsurface irrigation, sprinkler irrigation and drip irrigation.	
	1.3	Water Requirement of Crops: Crops and crop seasons in India, delta and duty of crops, relationship between delta and duty of crops. Soil water relationship and its significance from irrigation considerations, root zone soil water, infiltration, consumptive use, frequency of irrigation.	
2	**Hydrology**		07
	2.1	Hydrologic cycle, Precipitation: Forms and Types of precipitations.	
	2.2	Measurement of rainfall by rain gauges and stream flow measurement. calculation of missing rainfall data and adequacy of rain gauge stations.	
	2.3	Runoff: Runoff- factors affecting runoff, computation of runoff, yield of the catchment runoff hydrograph, flood discharge and its calculations.	
	2.4	Hydrograph: Flood hydrograph- Its components and base-flow separation, Unit hydrograph, application of unit hydrograph, methods of deriving unit hydrograph, S-hydrograph and its application.	
3	**Ground Water and Well Hydraulics**		05
	3.1	Ground water resources and occurrence of ground water.	
	3.2	Well hydraulics: steady state flow conditions in wells.	
	3.3	Equilibrium equations for confined and unconfined aquifer.	
	3.4	Aquifer tests.	
	3.5	Difference between open well and tube well, Well Losses	
4	**Dams and Spillways**		09
	4.1	Reservoir, various zones of storage reservoir, control level fixation for a reservoir. Introduction to reservoir sedimentation and control measures.	
	4.2	Gravity Dams: Definition, typical cross section and components of gravity dam, forces acting on gravity dam, modes of failure	

		of gravity dam, structural stability analysis of gravity dam, elementary and practical profile of gravity dam, low and high gravity dam, galleries in gravity dam – Function of gallery and different cross-sections of gallery adopted in practice, joints in gravity dam. control of cracking in concrete dams.	
	4.3	Earthen Dam: Types of earthen dams and methods of construction of earthen dam, causes and failures of earthen dams, seepage line/phreatic line for different conditions and its location using graphical method, seepage control through embankment and through foundations.	
	4.4	Spillways: Introduction, types of spillways – its working and functionality.	
5	**Irrigation Channels (Silt Theories)**		**06**
	5.1	Kennedy's theory and method of channel designs silt supporting capacity according to Kennedy's theory.	
	5.2	Lacey's regime theory and application of Lacey's theory for designing channel cross-section.	
	5.3	Comparison between Kennedy's theory and Lacey's theory.	
	5.4	Drawbacks of Kennedy's theory and Lacey's theory.	
	5.5	Introduction to sediment transport in channels.	
6	**Canal Headwork-Distribution System and Canal Structures**		**05**
	6.1	Canal Headwork and Distribution System: Classification of canals, canal alignment, canal losses, canal lining, water logging and remedial measures for water logging.	
	6.2	Canal Structures Canal Falls and types of canal falls, canal escapes and types of canal escapes, canal regulators and types of canal regulators, canal outlets and types of canal outlets, cross drainage works and types of cross drainage work.	
		Total	**39**

Contribution to Outcome

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

1 Describe National water Policy, Calculate Crop water requirement and Classify various types and methods of irrigation.

2 Estimate flood discharge and Runoff by traditional and modern usage tools for planning and management of water resources projects.

3 Apply knowledge on ground water, well hydraulics to estimate the safe yield and ground water potential

4 Analyze and design gravity dams and earthen dams with spillways for sustainable development

5 Compare different silt theories related to irrigation channel and design the same.

6 Classify and Explain various canal structures and suggest remedial measures for water logging to save fertile irrigation

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

1. Irrigation and Water Power Engineering: B.C. Punmia, PandeB.B.Lal, A.K Jain. Laxmi Publications Pvt, Ltd. New Delhi.
2. Irrigation Engineering and Hydraulic Structures: S.K. Ukarande, Ane Books Pvt. Ltd. ISBN-9789383656899.
3. Irrigation Water Resources and Water Power Engineering: P.N. Modi, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
4. Irrigation Engineering and Hydraulics Structures: S. K. Garg, Khanna Publishers. Delhi.
5. Design of Irrigation Structures: S. K. Sharma, S. Chand and Co.
6. Theory and Design of Irrigation Structures: R. S. Varshney and R, C. Gupta, Nem Chand
7. Engineering for Dams, Vol. I to III: Crager, Justin and Hinds, John Wiley
8. Design of Small Dams: USBR.
9. Hydro Power Structures: R. S. Varshney, Nem Chand and Bross.
10. Concrete Dams: R. S. Varshney, Oxford and IBH Publishing Co.

Semester VI

Course Code	Course Name	Credits
CEC603	Geotechnical Engineering-II	3

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

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

Rationale

Basic knowledge of analysis and design of foundations is very important for all civil engineers, more so for geotechnical and structural engineers. Soil testing (both field and lab tests) and its analysis are not only compulsory prerequisites for the analysis, design and construction of any major structure but also holds lucrative consultancy work and job opportunities in the field of civil engineering. Immense research opportunities are also available in this field.

Objectives

1 Students will gain knowledge of consolidation theory.

2 Students will evaluate the shear strength characteristics of the soil. Moreover, they would apply the knowledge for solving the related problems.

3 Students will analyze stability of slopes.

4 Students will analyze and evaluate lateral earth pressure.

5 Students will analyze and design shallow foundation.

6 Students will analyze and design deep foundation.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Module Name- Consolidation of soils**		**06**
	1.1	Compressibility & settlement, comparison between compaction & consolidation, concept of excess pore water pressure, initial, primary secondary consolidation, spring analogy for primary consolidation, consolidation test results, coefficient of compressibility, coefficient of volume change, compression, expansion, recompression indices, normally and over consolidated soils.	
	1.2	Terzhaghi's theory of consolidation (no proof)- assumptions, coefficient of vertical consolidation, distribution of hydrostatic excess pore water pressure with depth & time, time factor, relationship between time factor and degree of consolidation, determination of coefficient of vertical consolidation, pre-consolidation pressure.	
	1.3	Final settlements of a soil deposit in the field, time settlement curve, field consolidation curve.	
2	**Module Name- Shear strength**		**05**
	2.1	Introduction, frictional cohesive strength, state of stresses in soil mass, principal stresses, determination of stresses on an inclined plane by using analytical and Mohr's circle method, important characteristics of Mohr's circle.	
	2.2	Coulomb theory, Mohr-Coulomb theory- shear strength parameters; Mohr-Coulomb failure envelope- relation between major and minor principal stresses, total & effective stress analysis.	
	2.3	Different types of drainage conditions UU, CU and CD: Direct shear test, Triaxial compression test, Unconfined compression test, Vane shear test; comparison between direct & triaxial tests, interpretation of test results of direct shear & triaxial shear tests stress-strain curves.	
	2.4	Determination of shear strength of soil- pull out test and Introduction to liquefaction of Soils.	
3	**Module Name- Stability of Slopes**		**06**
	3.1	Introduction: Types of slopes, types of slope failures, factors of safety.	
	3.2	Stability analysis of infinite slopes in i) cohesionless soil and ii) cohesive soil under a) dry condition, b) submerged condition and c) steady seepage condition along the slope.	

	3.3	Stability analysis of finite slopes: i) Taylor's stability number ii) friction circle method iii) Swedish circle.	
4	**Module Name - Lateral Earth Pressure Theories**		**08**
	4.1	Introduction to Lateral Earth Pressure Theories: Concept of lateral earth pressure based on vertical and horizontal stresses, different types of lateral earth pressure	
	4.2	Rankine's earth pressure theory: i) assumptions, ii) active and passive states in cohesionless soil: effect of submergence, effect of uniform surcharge, effect of inclined surcharge iii) active and passive states in cohesive soil	
	4.3	Coulomb's wedge theory: i) assumptions, ii) active and passive states in cohesionless soil, iii) active and passive states in cohesive soil	
	4.4	Rehbann's Graphical Method (no proof)	
	4.5	Culmann's Graphical Method (no proof)	
5	**Module Name- Shallow Foundations**		**08**
	5.1	Introduction: types of shallow foundations, definitions of different bearing Capacities	
	5.2	Theoretical methods of determining bearing capacity of shallow foundations: i) Terzaghi's theory: assumptions, zones of failure, modes of failure, ultimate bearing capacity equations for general and local shear failure, factors influencing bearing capacity: shape of footing and water table, limitations of Terzaghi's theory ii) Vesic's theory: bearing capacity equation I.S. Code Method: bearing capacity equation	
	5.3	Field methods of determining bearing capacity of shallow foundations: i) standard penetration test and ii) plate load test	
6	**Module Name- Pile Foundations**		**06**
	6.1	Introduction to pile foundations: necessity of pile foundations, types of pile foundation.	
	6.2	Theoretical methods of determining load carrying capacity of pile foundations: i) static formulae and ii) dynamic formulae	
	6.3	Field method of determining load carrying capacity of pile foundations: pile load test	
	6.4	Group action of piles, settlement of pile groups, negative skin friction	
		Total Hours	**39**

Contribution to Outcome

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

1 Evaluate the consolidation parameters for the soil.

2 Calculate the shear strength parameters for the soil.

3 Calculate the factors of safety of different types of slopes under various soil condition, analyze the stability of slopes.

4 Calculate lateral earth pressure under various soil condition.

5 Calculate bearing capacity of shallow foundations using theoretical and field methods.

6 Calculate load carrying capacity of individual as well as group of pile foundation using theoretical and field methods and pile settlement.

Internal Assessment (20 Marks):

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

End Semester Examination (80 Marks):

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

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

2 **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**

3 **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only **Four questions need to be solved.**

Recommended Books:

1 Soil Mechanics and Foundation: Dr. B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain; Laxmi Publications

2 Soil Mechanics and Foundation Engineering: K.R. Arora; Standard publishers and Distributors

3 Soil Mechanics and Foundation Engineering: V.N.S Murthy; Saitech Publications

4 Geotechnical Engineering: C. Venkatramaiah; New age International

5 Theoretical Soil Mechanic: K. Terzaghi; John Wiley and Sons

6 Fundamentals of Soil Engineering: D. W. Taylor; John Wiley and sons

7 Relevant Indian Standard Specification Code: BIS Publications, New Delhi

8 Soil Mechanics in Theory and Practice: Alam Singh; Asia Publishing House

9 Geotechnical Engineering: Purushothama Raj; Tata McGraw Hill Publications

10 Basic and Applied Soil Mechanic: Gopal Ranjan and A.S. Rao; New Age International

Semester-VI

Course Code	Course Name	Credits
CEC604	Environmental Engineering	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
04	-	-	04	-	-	04

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

Rationale

Every civil engineer must be acquainted with the principles of public health engineering, purification of water, sewage collection, design of water and sewage treatment and develop rational approaches towards sustainable waste management via appropriate treatment and reuse. The course deals with the overall features and study of treatment of water, building drainage, rain water harvesting, sewage treatment processes and solid waste management. The course also lays emphasis on the knowledge of Air and Noise pollution.

Objectives

1 To demonstrate the necessary knowledge and concepts in the fields of water supply and quality of water.

2 To impart necessary skill for the design and operation of various units of water treatment facilities.

3 To recognize the necessary knowledge of good plumbing system, building drainage and rainwater harvesting.

4 To demonstrate the necessary knowledge on domestic sewage and Sewerage system.

5 To develop a flow Content for sewage treatment and design its units.

6 To impart the basic understanding of Air pollution, noise pollution and solid waste so as to control its adversity on ambient environment.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Water Supply and Quality Of Water**		04
	1.1	Water supply: Water supply systems, water resources, types of intake structures, distribution systems of water and distribution layouts.	
	1.2	Quality of water: Introduction to pure water: potable, wholesome, palatable, distilled, polluted and contaminated water, drinking water standards and characteristics of water, water borne diseases.	
2	**Water Treatment**		15
	2.1	WTP: Typical layout of WTP, Aeration, Types of Aeration systems, sedimentation, types of settling, tube settlers, design of sedimentation tank.	
	2.2	Coagulation and flocculation: Principle of coagulation, flocculation, Clari flocculator, coagulants aids.	
	2.3	Filtration: rapid sand filters, operation, cleaning and back-washing, Entire design of rapid gravity filter with under drainage system. Pressure filter: Construction and operation	
	2.4	Disinfection: Different methods of disinfection, chlorination and chemistry of chlorination, chlorine demand, free and combined chlorine, various forms of chlorine, types of chlorination. Numerical to calculate quantity of required chlorine doses.	
	2.5	Advanced and Miscellaneous Treatments: Water softening by lime soda process and by base exchange method, Reverse Osmosis, Activated carbon, Membrane filtration, Removal of Iron and Manganese.	
3	**Building Water Supply, Drainage and Rainwater Harvesting**		04
	3.1	Building water supply: Water demands, Per capita Supply, Service connection from main, Water meter.	
	3.2	Building drainage: basic principles, traps-types, location and function, Systems of Plumbing, anti siphonic and vent pipes.	
	3.3	Rainwater harvesting: Need for rainwater harvesting, Annual potential, Roof-top rain water harvesting. Numerical on annual rainwater harvesting potential.	

4	**Domestic Sewage and Sewerage System:**		**08**
	4.1	Sewage: Introduction to domestic sewage, and storm water, System of sanitation, Physical and chemical characteristics, decomposition of sewage, BOD, COD, numerical on BOD. MPCB norms for disposal of sewage effluent.	
	4.2	Sewerage system: Systems of sewerage and their layouts: Separate, Combined and partially combined system, merits and demerits, self-cleaning velocity and non-scouring velocity, Sewer- Shape, hydraulic design of sewers, Laying and testing of sewers, manhole-location, necessity, types and drop manhole, ventilation	
5	**Sewage Treatment**		**15**
	5.1	Treatment processes: Objective, methods of treatment, flow sheets showing Preliminary, Primary, Secondary and Tertiary treatment. Primary treatment: Screening, Grit removal, Oil and Grease removal, settling tank.	
		Secondary Treatment Methods: Trickling filter- Principle, Process description and Design of trickling filter. Activated sludge process (ASP) - Principle, Process description, Recirculation of sludge, (numerical), Sludge volume index.	
	5.2	Introduction to Biological Treatment: Aerated lagoons, Oxidation ponds, oxidation ditches.	
		Self-purification of natural waterbodiess: Oxygen economy, Disposal of treated effluent. Disposal of Raw and treated sewage on land and water, DO sag curve.	
	5.3	Rural and Low-cost sanitation: Septic Tank and Soak Pit – Operation, suitability and Design	
6	**Air Pollution, Noise Pollution and Municipal Solid Waste Management**		**06**
	6.1	Air pollution: Composition of air, Quantification of air pollutants, Air quality standards, Effect of air pollution on Environment, Introduction to Air pollution control devices.	
	6.2	Noise pollution: Basic concept and measurement, Effects of noise, and control methods, and numerical on sound level.	
	6.3	Municipal Solid Waste Management: Sources, storage, treatment, disposal,5R Principles.	
		Total	**52**

Contribution to Outcome

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

1 Analyse the quality of water and make outline of water Supply scheme.

2 Design the various units of water treatment plant and apply the advanced, miscellaneous treatments whenever necessary.

3 Build service connection of water supply from main and building drainage system at construction site along with rain water harvesting layout.

4 Analyse and plan sewerage system along with test for sewer line.

5 Design the units of sewage treatment plant. Also, able to apply the knowledge of low-cost treatment and stream sanitation.

6 Understand air pollution, noise pollution and functional elements of solid waste management.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –

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

Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

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

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

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Site Visit:

The students will visit to sewage treatment plant/ water treatment plant in the nearby vicinity or in the city and prepare detailed report thereof. This report will form a part of the term work

Recommended Books:

1 Water Supply Engineering: S. K. Garg, Khanna Publication.

2 Water Supply Engineering: P.N. Modi, Rajsons Publication.

3 Water Supply and Sanitary Engineering: S.K. Hussain, Oxford & IBH Publication, New Delhi

4 Environmental Engineering: *B. C. Punmia*, Laxmi Publications, New Delhi.

5 Solid waste management in developing countries: A.D. Bhide and B.B. Sundaresan

6 Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: *S. K. Garg*, Khanna Publishers New Delhi

7 Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian

8 Integrated solid waste management, Tchobanoglous. Theissen and Vigil, McGraw Hill Publication.

Reference Books:

1 Manual on Wastewater Treatment 3rd Ed. Pub: CPH and Env. Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1991.

2 Plumbing Engineering, Theory and Practice: *Patil S. M.,* Seema Publication, Mumbai.

3 Manual on Municipal Solid Waste Management: Ministry of urban development, New Delhi.

4 Water Supply and Sewerage:*E.W. Steel.*

5 Manual on Water Supply and Treatment, (latest Ed.): Ministry of Urban Development, New Delhi.

6 Water supply and pollution control: J.W. Clark, W. Veisman, M.J. Hammer, International textbook company.

7 CPHEEO Manual on Water Supply and Treatment.

8 CPHEEO Manual on Sewage and Treatment.

9 Environmental Engineering: Peavy,H.S., RoweD.R., TchobanoglousG.; 1991, Tata-Mcgraw Hill.

Semester-VI

Course Code	Course Name	Credits
CEDLO6011	Department Level Optional Course -2 Rock Mechanics	03

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

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

Rationale

The Civil Engineering structures are built on or through rocks. The design of structures depends on the rock mass properties and the interaction between the rock and the structure. This demands the study of deformation resulting from the strain of rocks in response to various stresses working on them. The mechanisms and character of the deformation of rocks can be investigated through laboratory experiments. The course will give an idea of in- situ testing of the rock and observation of geological conditions that can affect the way a rock behaves when subjected to loads and stresses.

Objectives

1 To provide basic knowledge of Rock -Mechanics to understand design aspects of various structures on or through rocks.

2 To study the various classification schemes of rock masses and their application.

3 To study the physical properties of rocks and various lab test conducted on them to determine the strength.

4 To determine properties and behavior of various types of rock under different loading conditions.

5 To study bearing capacity, stress distribution and factor of safety within the rock.

6 To study the stability of rock slopes and design aspects of openings in/on the rocks.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Structural Geology and Data Interpretation**		05
	1.1	Introduction to Rock Mechanics and Importance	
	1.2	Geological classification of rocks	
	1.3	Description of discontinuities and their effect on rocks	
	1.4	Stereographic Analysis of structural Geology	
2	**Engineering Classification of Rocks and Rock Masses:**		06
	2.1	Classification of intact rocks. Rock mass classifications: Rock Quality Designation (RQD), Rock Structural Rating (RSR), Rock Mass Quality (Q system).	
	2.2	Strength and Modulus from classifications, classification based on Strength and Modulus.	
	2.3	Geo-mechanics (RMR)} and Geo-engineering classification	
	2.4	Deere and Miller's Engineering Classification	
3	**Laboratory Testing of Rocks: Field and Laboratory Tests on Rocks**		07
	3.1	Determination of physical properties of rocks	
	3.2	Uniaxial Compressive Strength Test	
	3.3	Tensile Strength Test	
	3.4	Direct Shear Test and Triaxial Test	
	3.5	Slake Durability Test	
	3.6	Schmidt Rebound Hardness, Swelling Pressure and Free-Swell, Void Index, Hydraulic fracture, Flat Jack Test	
4	**Strength, Modulus and Stress-Strain Responses of Rocks:**		07
	4.1	Factors influencing rock responses, Strength criteria for isotropic intact rocks, Modulus of isotropic intact rocks.	
	4.2	Uni-axial Compressive Strength of intact anisotropic rocks, Strength due to induced anisotropy in rocks, Compressive Strength and Modulus from SPT.	
	4.3	Stress- strain models (constitutive models, elastic stress-strain model, elastic-plastic stress-strain model, Visco-elastic Model.	
5	**Bearing Capacity of Rocks:**		06
	5.1	Estimation of bearing capacity (foundation on intact rock, heavily fractured rock), UBC with Hoek-Brown criterion, foundation on slope	
	5.2	Stress distribution in rocks, Factor of safety, strengthening measures (concrete shear keys, bored concrete piles, tensioned	

		cable anchors, concrete block at toe),	
	5.3	Settlement in rocks (from joint factor, for horizontal joints, from field tests).	
6	**Stability of Rock Slopes & Opening in Rocks**		**08**
	6.1	Modes of failure, rotational failure, plane failure, wedge method of analysis, buckling failure, toppling failure, application of stereographic projection, Remedial measures.	
	6.2	Rock Bolting and Grouting: Methods to improve rock mass responses, grouting in rocks, objectives, contact grouting, consolidation grouting, process of grouting, grout requirement, types of grout, stage grouting, grout curtain. Rock Bolting Rock anchors.	
	6.3	Tunneling: Ground conditions in tunneling, Computing structural discontinuities in rock masses, requirement of lining in tunnels, pressure tunnels and tunnels for other purposes, application of stereographic projection.	
		Total	**39**

Contribution to Outcome

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

1 Explain basic concepts of Rock -Mechanics and apply it to design aspects of various Civil Engineering structures on or through the rocks.

2 Classify the rock masses and evaluate them for various Civil Engineering works.

3 Explain the laboratory testing of rocks and determine the physical properties and strength of intact rocks and rock masses.

4 Explain the stress-strain responses of the rocks and influencing factors.

5 Determine the bearing capacity and factor of safety of rocks.

6 Determine the stability of slopes and underground excavations.

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –

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

Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

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

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

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

1 Introduction to Rock Mechanics: Goodman, RE (1989), Canada, Jhon Wiley & Sons.

2 Rock Slope Engineering, Hoek, E and Bray, JW (1977), The Institution of Mining and Metallurgy, London.

3 Rock Mechanics and Design of Structures on Rock: *Obert, Leon and W. I. Duvall*.

4 Engineering Rock Mass Classification, Singh, B and Goel RK (20011), Oxford, UK, Elsevier Inc.

Reference Books:

1 Rock Mechanics in Engineering Practice: *K. G. Stagg and O. C. Zienkiewicz*, John Willey and Sons, New York.

2 Rock Mechanics – Vol. I and II: *Jumukis*, Trans Tech Publication, USA.

3 Fundamentals of Rock Mechanics: Jaeger, JG, Cook, NGW and Zimmerman, RW (2007) 4 th Ed., Singapore, Blackwell Publishing

4 Rock Mechanics and Design of Structures on Rock: Obert, Leon and W. I. Duvall.

Semester-VI

Course Code	Course Name	Credits
CEDLO6012	Department Level Optional Course - 1 Biological Process and Contamination Removal	03

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

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

Rationale

Biological treatment processes are widely used in both developed and developing countries to control and accelerate the natural process of organic matter decomposition. The process is often used to treat biodegradable waste materials released from domestic, commercial and industrial sources before they are disposed of. However, it is also observed to further treat the wastewater for contamination removal in order to remove and treat toxic materials. The course deals with the overall features and study of biological treatments of wastewater and contamination removal. The course lays emphasis on complete updates of these processes and knowledge related to design of treatment units.

Objectives

1 To understand quality, quantity, characteristics and treatment process of wastewater generated from various sources

2 To understand the biological process and treatment of wastewater.

3 To provide students the necessary knowledge and concepts of advancements/ emerging techniques of Microbial Growth Kinetics, Utilization of soluble substrate and biotechnological remedies

4 To study and design the aerobic decomposition and its application in Aerobic Suspended Growth Biological Treatment Systems.

5 To study and design the anerobic decomposition and its application in wastewater treatment.

6 To develop rational approaches towards natural and biotechnological methods for contamination removal.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Waste Water Generation, Collection and Conveyance**		08
	1.1	Introduction: Domestic waste water, Industrial Wastewater and Stormwater, Conservancy and Water carriage system, Systems of sewerage, Quantity and Quality of Wastewater.	
	1.2	Need for Analysis, Characteristics of wastewater: Analysis of wastewater, Characteristics of wastewater and sampling, Composition, Biochemical characteristics, aerobic decomposition, anaerobic decomposition,	
	1.3	Waste Water Treatment and Flow diagram: Treatment processes: Objective, methods of treatment, flow sheets showing Preliminary, Primary, Secondary and Tertiary treatment. Waste Water Treatment Plant and Effluent Treatment Plants. Various combinations and options. Low-cost treatment plant.	
2	**Introduction to Biological Treatment:**		03
	2.1	Overview of biological wastewater treatment, objectives of the treatment, role of microorganisms, types of biological processes for wastewater treatment, suspended and attached growth systems.	
3	**Microbial Growth Kinetics**		06
	3.1	Microbial Growth Kinetics terminology, rate of utilization of soluble substrates, rate of biomass growth with soluble substrate, rate of oxygen uptake, effects of temperature, total volatile suspended solids and active biomass, net biomass yield and observed yield.	
	3.2	Biotechnological remedies - Bio-fertilizers, Physical, chemical and Microbiological factors of composting, Health risk – Pathogens, Odor management, Microbial cell/enzyme technology, Adapted microorganisms, Biological removal of Nutrients.	
4	**Aerobic Decomposition:**		08
	4.1	Aerobic Suspended Growth Biological Treatment Systems: Aerobic biological oxidation, process description, environmental factors, Modifications of ASP: Complete Mix activated sludge, Extended Aeration system, Oxidation Ditch systems, Oxygen activated sludge, Oxidation ponds, Stabilization ponds, Aerobic attached Growth Biological Treatment-Trickling Filter.	
	4.2	Design of ASP, Trickling Filter, Oxidation Pond, Oxidation Ditch and Aerated lagoons.	

5	**Anaerobic Decomposition:**		**08**
	5.1	Anaerobic Decomposition: Mechanism of anaerobic fermentation – a multistep process, Microbiology and Biochemistry of Anaerobic processes, Substrate inhibition, Stuck reactors, Standard rate, High rate and Multistage anoxic digesters. Introduction to UASB.	
	5.2	Design of anaerobic treatment units: Anaerobic Lagoons	
6	**Natural and Biotechnological Methods of Contamination Removal:**		**06**
	6.1	Natural Treatment Systems: Development of natural treatment systems, Rapid infiltration systems, Overland Flow systems, constructed wetlands, Floating aquatic plant treatment systems. Introduction to engineering Fundamentals of Biotechnology. Heavy Metal Removal using advance treatment methods – Membrane filtration, Reverse Osmosis and Ion exchange.	
		Total	**39**

Contribution to Outcome

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

1 Determine and analyze the characteristics of wastewater and decide the treatment for wastewater.
2 Understand biological treatment process and necessity of contamination removal
3 Understand and apply the concepts of advancements/emerging techniques of Microbial Growth Kinetics, Utilization of soluble substrate and biotechnological remedies.
4 Summarize the concept of aerobic decomposition and its application in Aerobic Suspended Growth Biological Treatment Systems
5 Summarize the concept of the anaerobic decomposition and its application in wastewater treatment.
6 To derive the knowledge and develop rational approaches towards natural and biotechnological Methods for contamination removal

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

4 Only Four questions need to be solved.

Recommended Books:

1 Wastewater Engineering Treatment, Disposal, Refuse: Metcalf and Eddy, T.M.H. Edition, New Delhi, 1995.

2 Environmental Engineering Vol II- Sewage Disposal and Air Pollution Engineering: S. K. Garg, Khanna Publishers New Delhi.

3 Water supply and sanitary Engineering: Hussain S. K., Oxford and IBH Publication, New Delhi.

4 Wastewater Treatment for Pollution Control and Reuse by Soli. J Arceivala (Author), Shyam. R Asolekar.

5 Environmental Engineering: B. C. Punmia, Laxmi Publications, New Delhi.

6 Water Supply and Sewerage: E.W. Steel.

7 Introduction to Environmental Engineering, Vesilind, PWS Publishing Company 2000.

8 Introduction to Environmental Engineering: P. Aarne Vesilind, Susan M. Morgan, Thompson.

9 Wastewater Treatment- Concepts and Design Approach: G. L. Karia and R. A. Christian.

10 Basic Principles of Wastewater Treatment Book by Marcos Von Sperling.

Reference Books:

1 Manual on Wastewater Treatment 3rd Ed. Pub: CPH and Env. Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1991.

2 CPHEEO Manual on Sewage and Treatment.

3 Relevant Indian standard specifications and BIS publications.

4 Handbook of Water and Wastewater Treatment Plant Operations Book by Frank R. Spellman

Semester-VI

Course Code	Course Name	Credits
CEDLO6013	Department Level Optional Course-2 Construction Equipment & Techniques	03

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

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

Rationale

Machines have revolutionized every sphere of human being's life. Engineering constructions also have seen a drastic reformation due to introduction of various construction equipment and techniques. This course provides an extensive overview of advanced equipment used in construction industry and also discusses certain methods/techniques used to construct facilities using these equipments. It makes the student aware of the equipment/techniques required while constructing different kinds of civil engineering structures. Student will be introduced to some emerging technologies in the field of Civil engineering which will make them more industry ready.

Objectives

1 To understand the characteristics and complexities involved in large civil engineering projects so that the equipment/technique requirements of a project can be listed out.
2 To know the various conventional techniques/equipments used in civil engineering projects.
3 To get acquainted with the modern equipments/techniques which have replaced the conventional ones.
4 To select the appropriate equipment/techniques in construction for large and heavy engineering projects on the basis of suitability, availability, productivity, output, initial and operation cost, savings in time and other resources, etc.
5 To understand the characteristics and complexities involved in large civil engineering projects so that the equipment/technique requirements of a project can be listed out.
6 To know the various conventional techniques/equipments used in civil engineering projects.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction**		06
	1.1	Equipment v/s Labour, Standard and Special equipments, Types of costs related to equipments including related numerical, Equipment life and Replacement decisions including related numerical, Cycle time, Balancing of equipments and related numerical.	
	1.2	Different categories of construction equipments used conventionally with reference to available types and their output, working mechanism, factors affecting their performance and criteria for selecting a particular equipment: Earthmoving and other hauling equipment, Pavers for road construction. Numbering and Record maintaining of Earthmoving and other hauling equipment's; Pile driving equipment; Applications of Air compressor. Dewatering techniques for trenches; Stone crushing equipment.	
2	**Underground & Underwater Tunnelling**		09
	2.1	Various purposes for which tunnelling may be carried out, Basic terms related to tunnelling. Conventional methods of carrying out tunnelling in different types of soils/rocks. Methods for dewatering tunnels.	
	2.2	Detailed Procedure for underwater tunneling. Modern methods of tunnelling and detailed study of following equipments/ techniques in this regard. Use of drones, construction robots for aerial surveys. Use of GPS and remote sensing for setting out tunnel alignment. Jumbo – used for drilling and blasting, Blasting Techniques for quarrying stones for construction purpose. Diaphragm wall construction and other ground stabilization methods. Vertical shaft sinking machine (VSM). Tunnel Boring machine (TBM), Micro tunneling. New Austrian tunnelling method (NATM). Cut & cover method, Top to bottom construction. Tunnel lining trolley. Tunnelling for Metro projects. Difference in Tunnelling for Roads and Metros.	
3	**Modern Formwork Systems and Working Techniques in Limited Space**		06
	3.1	Difference in conventional and modern systems of formwork Mivan, Doka shuttering along with their advantages and disadvantages. Modular shuttering, Slip and jump form.	
	3.2	High rise construction: Concrete making on mass scale, pumping and placing booms. Tower cranes and the benefits they offer for high rise construction. Range diagram.	

	3.3	Prefabricated housing systems, Difficulties faced in the installation and operation of all these systems. Emergency housing for disaster management.	
	3.4	Working skills/tricks required for managing a site in urban/restricted space environment. Techniques for controlled demolition of buildings.	
4	**Equipments For Laying of Utility Lines, Bridge Construction & Installation of Structural Steel Members.**		**06**
	4.1	Use of ground penetrating radar (GPR) for locating underground utilities. Laying of pipes using pipeline insertion system. Installation and operation of underground power transmission lines as well as overhead transmission towers.	
	4.2	Incremental launching method and balanced cantilever method of bridge/flyover construction with reference to the recent infrastructure developed in the local and global context.	
	4.3	Equipments/techniques used for connecting structural steel components of bridge decks, terminals, malls, stadiums, car sheds, etc.	
5	**Equipments/ Techniques for Setting Up of Power Generation/Supply Structures.**		**06**
	5.1	Hydropower station. Tidal power plants. Desalinization plants. Thermal power station. Solar power station. Atomic power generation. Installation and operation of wind mills. Construction of a fuel station.	
6	**Equipments/ Techniques for Construction of Transporting Facilities**		**06**
	6.1	Construction of railway lines using track laying machine. Methods, techniques and equipments involved in the construction of Metro, mono and maglev trains. Connecting link between underground and overhead metro systems. 5D BIM integration in Metro projects.	
	6.2	Equipments required for construction and operation of an airport and sea port. Application of Drones, GIS, GPS and BIM for monitoring project progress/working of Airports and Seaports. Piling Equipment's for Jetty Construction.	
	6.3	Light Detection and Ranging (Lidar) Technique for Railways/ Highways/ Bullet train alignments.	
		Total	**39**

Contribution to Outcome

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

1 Understand the use/applications of various conventional construction equipments and select the best out of them for a particular site requirement.
2 Know modern methods/equipments used for underground as well as underwater tunnelling.
3 Compare conventional and modern methods of formwork and get acquainted with techniques used on sites with restricted space.
4 Understand the techniques involved and the equipments required thereof for laying of utility lines, bridge construction and installation of structural steel members.
5 Gain knowledge about the setting up of different kinds of the power generating structures.
6 Get acquainted with the equipments/ techniques for construction of transporting facilities.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

1 Construction Equipment & Planning. Purifoy, R.L & Ledbetter McGraw Hill
2 Construction Equipment & its Management. Sharma, S. C. Khanna Publishers
3 Tunnel Engineering HandbookThomas R. Kuesel, Elwyn H. King, John O. Bickel Springer
4 Practical tunnel construction Gary B. Hemphill Wiley Publishers
5 Success with drones in Civil Engineering Brett Hoffstadt Kindle
6 Construction Technology for Tall BuildingsMichael Yit Lin Chew World Scientific
7 The prefabricated home Colin DaviesReaktion Books
8 Literature/specifications/downloadable videos available on Doka and Mivaan shuttering websites.
9 Accelerated Bridge Construction: Best Practices and Techniques Mohiuddin Ali Khan BH Elsevier

Reference Books:

1 Design and Construction of Nuclear Power Plants Rüdiger Meiswinkel, Julian Meyer, Jürgen Schnell Wiley Publishers

2 Energy and Power generation handbook K.R Rao ASME Press

3 Magnetic Levitation Hyung-Suk Han Dong-Sung Kim Springer

4 Metro Rail Projects in India M Ramachandran Oxford

5 BIM Handbook Eastman,Teicholz,Sacks,Liston John Wiley and Sons

6 IRC:43-2015 Recommended Practice for Plants, Tools and Equipment Required for Construction and Maintenance of Concrete Roads (First Revision).

7 IRC-2018 Pocket book for Road Construction Equipment.

8 IRC: SP-97- 2013 Guidelines on Compaction Equipment for Roads Works

Semester-VI

Course Code	Course Name	Credits
CEDLO6014	Department Level Optional Course -2 Urban Infrastructure Planning	03

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

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

Rationale

Indian cities are currently expanding at a rapid rate, and are therefore facing immense pressure for the improvement of their services and infrastructure. Without coordination and planning for the anticipated spatial growth and densification, the infrastructure services are neglected. Such growth areas can become under-serviced places of the cities, one from which many problems of the city stem: water, sanitation and waste problems, uncontrolled pests, and crime due to poor access to water and sanitation services. To address the emerging issues of urban centre, there is a pressing need to train urban infrastructure specialists who can comprehensively plan for city's growing infrastructure needs and formulate projects for efficient infrastructure service delivery for existing areas. There are ample urban infrastructure challenges and opportunities in terms of planning; effective policy, program and project formulation for well-trained young urban infrastructure professionals with specific domain knowledge

Objectives

1 Describe an infrastructure system using accurate terminology;
2 Demonstrate an understanding of the main concepts and principles of infrastructure planning;
3 Identify the key features of a sustainable infrastructure system and explain how they promote sustainable development;
4 Apply analytical tools for infrastructure planning;
5 Critically evaluate infrastructure cases/projects/proposals through the lens of sustainability;
6 Identify the gaps between theoretical principles of sustainable infrastructure and their application in practices

Detailed Syllabus			
Module	**Course Module / Contents**		**Periods**
1	**Introduction to Planning**		**04**
	1.1	Origins and growth of cities, effects of cultural influence on physical form; Human settlements as an expression of civilizations; Basic elements of the city; Concepts of space, time, scale of cities.	
	1.2	Contribution of housing to micro and macro economy, contribution to national wealth and GDP, housing taxation, national budgets, fiscal concessions; need of affordable housing for urban poor, concept of RERA	
2	**Urban Economics**		**06**
	2.1	General introduction to principles of economics and public finance. Importance of economics in Urban Development and Planning	
	2.2	Industrial location policies, any other economic activity base policies and their impact on urban development, Role of land economics in preparation of Urban Development plans. Relevant case studies of Urban Land Economics.	
	2.3	Economic growth and development, quality of life; Human development index, poverty and income distribution, employment and livelihood; Economic principles in land use planning; Policies and strategies in economic planning, balanced versus unbalanced growth, public sector dominance; changing economic policies, implications on land.	
3	**Infrastructure Planning**		**12**
	3.1	Role of Infrastructure in Development, Elements of Infrastructure (physical, social, utilities and services); Basic definitions, concepts, significance and importance; Data required for provision and planning of urban networks and services; Resource analysis, provision of infrastructure, and land requirements; Principles of resource distribution in space; Types, hierarchical distribution of facilities, Access to facilities, provision and location criteria, Norms and standards, etc.	
	3.2	Zoning, Various growth patterns of town, Housing layouts and road networks in town, Urban aesthetics and landscaping, MRTP and Land Acquisition Acts	
		Planning and Management of Water, Sanitation and Storm Water; Water – sources of water, treatment and storage, transportation and distribution, quality, networks, distribution losses, water harvesting, recycling and reuse, norms and standards of provision, institutional arrangements, planning	

		provisions and management issues; Sanitation – points of generation, collection, treatment, disposal, norms and standards, grey water disposal, institutional arrangements, planning provisions and management issues. Storm water – rainfall data interpretation, points of water stagnation, system of natural drains, surface topography and soil characteristics, ground water replenishment, storm water collection and disposal, norms and standards, institutional arrangements, planning provisions and management issues;	
	3.3	Solid Waste Disposal and Management Basic principles, generation, characteristics, collection, disposal, management	
	3.4	Fire and Electrification, and Social Infrastructure Planning for fire protection, services and space standards, location criteria; Planning for Education, health, civic, cultural infrastructure and facilities for transport and other miscellaneous infrastructure services	
	3.5	Planning for Education, health, civic, cultural infrastructure and facilities for transport and other miscellaneous infrastructure services	
4	**Traffic and Transportation Planning**		**07**
	4.1	Evaluation of urban structure: Transport system, infrastructure and management, transport systems and their types, design and operating characteristics, urban road hierarchy, planning, and management criteria for road and junction improvements, arterial improvement techniques.	
	4.2	Traffic management, mass transit system: Problems and prospects. Review of existing traffic management schemes in Indian cities. Case study of various metro rail project envisaged for Mumbai, Navi Mumbai & Pune.	
	4.3	Economic evaluation: pricing and funding of transport services and systems, economic appraisal of highway and transport projects. Techniques for estimating direct and indirect road user costs and benefit value of time	
	4.4	Intelligent transport system (ITS) its types and applications	
5	**Urban Management and Governance**		**06**
	5.1	Introduction to Development Management and Urban Governance- Concept, approaches, components, interface with national goals and political economic system. Urban Development Management Strategies, Tools and Techniques; organizations involved Land and Real Estate Development Economic concepts of land, Land Pricing / valuation; Urban reforms and acts and policies. Overview of Urban Governance Definition, concepts, components, government and governance, hierarchy and structure, forms of governance, process of inclusion and exclusion.	

	5.2	Information System and Urban Reforms Spatial and Non - spatial information systems; Use of GIS in overlaying infrastructure facilities, use of remote sensing in identifying and mapping urban structures.	
	5.3	Present organizations and involved in urban governance with focus on MCGM, TMC and CIDCO. Urban Local Governance and Participatory Processes System, structure, functions, powers, process and resource, performance, interface with NGO's, other agencies.	
6	**Environmentally Safe and Disaster Resilient Infrastructure**		**04**
	6.1	Frame work, statement prediction and assessment of impacts of air, water, noise, cultural and socio-economic environment. Methods of impact analysis, public participation. Environmental protection international and national agencies and legislation, Environment Impact Assessment. Urban Heat Island Effect, Effect of uncontrolled growth of town	
	6.2	Disaster response planning, roles and responsibilities of various agencies Emergency operation support and management Planning for Disaster Prone Areas, Planning requisites for disaster prone areas and preventive measures, Vulnerability analysis	
		Total	**39**

Contribution to Outcome

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

1 Explain the concepts related to planning of modern cities, GDP contribution, RERA, affordable housing

2 Elaborate the economics involved in urban infrastructure planning

3 Envisage the various elements required for infrastructure development of a city and describe the concepts, significance and importance of each

4 Evaluate technical, social and economic feasibility of transportation projects within cities

5 Demonstrate modern tool usage for urban management and governance

6 Design environmentally safe and disaster resilient infrastructure

Internal Assessment **20 Marks**

Consisting of two Compulsory Class Tests –

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

Average of marks will be considered for IAE.

End Semester Examination **80 Marks**

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

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

Recommended Books:

1 The Urban and Regional Planning Reader, edited by Eugenie L. Birch, Published by Routledge, 2008; ISBN 978-0-415-319
2 Housing: The Essential Foundations, edited by Dr. Paul Balchin, Paul Balchin, Maureen Rhoden, Edition Routledge, DOI https://doi.org/10.4324/9780203010426, eBook ISBN 9780203010426
3 New Urban Housing by Hilary French, Publisher: Yale University Press, ISBN0300115784 (ISBN13: 9780300115789)
4 Sociology: A Brief Introduction, by Richard T. Schaefer, Publisher: McGraw-Hill Education, ISBN 10:1259425584, ISBN 13: 9781259425585
5 Sociology: Principles of Sociology with an Introduction to Social Thoughts, by Rao C.N. Shankar, S. Chand Publication
6 Projects: Preparation, Appraisal, Budgeting and Implementation by Prasanna Chandra, Tata McGraw-Hill; ISBN0074516280 (ISBN13: 9780074516287)
7 Introduction to Transportation Planning, by B. Bruton, Michael J. Bruton; Published by Hutchinson Radius; ISBN0091580412 (ISBN13: 9780091580414)

Reference Books:

1 Modern Economics by H.L. Ahuja, 19th Revised Edition, Published by S.Chand (G/L) & Company Ltd
2 Economics, An Introductory Analysis by Paul A. Samuelson, William D. Nordhaus, Published July 27th 2004 by Irwin/McGraw-Hill (first published 1948), ISBN0072872055 (ISBN13: 9780072872057)
3 Modelling Transport, by de Dios Ortuzar and Luis G. Willumsen, 4th Edition, Wiley Publication
4 Principles of Urban Transport Systems Planning, by B.G. Hutchinson, Publisher: Scripta Book Co.; ISBN0070315396 (ISBN13: 9780070315396)
5 Traffic Engineering and Transport Planning, L. R. Kadiyali, Khanna Publishers, 1983
6 Remote Sensing and GIS, by Basudeb Bhatta, second Edition, Oxford University press
7 NEPA and Environmental Planning: Tools, Techniques, and Approaches for Practitioners; Charles H. Eccleston; CRC Press
8 Planning for Disaster: How Natural and Manmade Disasters Shape the Built Environment, by William Ramroth; Publisher: Kaplan Business; Original edition; ISBN-13: 978-1419593734.

Semester-VI

Course Code	Course Name	Credits
CEDLO6015	Department Level Optional Course -2 Open Channel Flow	03

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

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

Rationale

Civil engineers deal with the analysis and design of irrigation systems which include dams, weirs, barrages, canals, drains and other supporting systems, for which good knowledge of dynamics of open channel flow is very much essential. Hence this course is designed to study different types of flow like uniform flow, non- uniform flow, spatially varied flow, and unsteady flow occurring in open channels. Competencies developed by this course would therefore be useful for students to handle and solve the practical problems/ issues in the field of Water resource management, Water shed Management etc. It is expected that the students will be better equipped to address various engineering problems related to hydrology and hydraulics.

Objectives

1 Understand the nature of flow, explain the basic concepts of uniform flow and to design the best hydraulic sections in open channel.
2 Apply the Energy concepts of fluid in open channel and demonstrate various flow measurement devices in open channels.
3 Develop Dynamic equation to compute the flow profiles for Gradually varied flow and classify water profiles in prismatic channels with different slope conditions.
4 Illustrate the causes of Rapidly varied flow, predict the formation of hydraulic jump and its applications.
5 Determine different types of spatially varied flow with varying discharges and characteristics of water surface profiles.
6 Study and analyze the temporal flow variations in open channel and the formation of surges.

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Uniform Flow**		07
	1.1	Flow through open channel, Types of channels, open and covered channels, Classification of flow in channel, Geometrical properties, velocity distribution in a channel section	
	1.2	Uniform flow in open channels, Discharge through open channel, Manning's and Chezy's Equation, Determination of roughness coefficients,	
	1.3	Determination of Conveyance of a channel, Hydraulic mean depth, Normal depth and Normal velocity, computation of uniform flow	
	1.4	Most economical sections of prismatic channels, condition for maximum velocity in a circular channel, condition for maximum discharge in a circular channel	
2	**Energy-Depth Relationships**		07
	2.1	Specific energy, Specific energy curve, Depth- Discharge diagram, critical depth, critical slope, critical flow, alternate depths	
	2.2	Condition for maximum discharge for a given value of Specific energy	
	2.3	Momentum in open channel flow- Specific force, specific force diagram, Dimensionless specific force diagram,	
	2.4	Critical flow and its computation, Application of specific energy and discharge diagrams to channel transitions	
	2.5	Metering Flumes- Venturi flume, Standing wave flume, Parshall flume, Determination of mean velocity of flow, Measurement of discharge in Rivers	
3	**Non-Uniform Flow: Gradually Varied Flow**		07
	3.1	Dynamic equation of Gradually Varied Flow (GVF) in rectangular and wide rectangular channels	
	3.2	Types of slopes- channel bottom slopes and water surface slopes, classification of channel bottom slopes and surface profiles	
	3.3	Characteristics of surface profiles, Backwater curve and drawdown curve	
	3.4	Computation of GVF-Direct Step and Standard step method, Numerical methods, Graphical Integration method	

4	**Non-Uniform Flow: Rapidly Varied Flow**		**07**
	4.1	Rapidly varied flow (RVF), Hydraulic Jump, Momentum equation for the jump	
	4.2	Hydraulic jump in a rectangular channel, Froude Number before and after jump, Classification of jumps, Characteristics of jump in a rectangular channel	
	4.3	Jumps in non-rectangular channel, applications of jump, location of jump, surges in open channel	
	4.4	Use of RVF for flow measurement purpose-Sharp crested weir, Broad crested weir, Ogee spillway, sluice gate	
5	**Spatially Varied Flow**		**06**
	5.1	Importance of Spatially Varied Flow (SVF), Causes, Continuity, Momentum and Energy Equation	
	5.2	Water surface profiles, Applications, Differential Equation for SVF with increasing and decreasing discharge–	
	5.3	Relevant case studies	
6	**Unsteady Flow**		**05**
	6.1	Basic concepts of Gradually varied unsteady flow, Rapidly varied unsteady flow	
	6.2	Positive and negative surges	
	6.3	Relevant case studies	
		Total	**39**

Contribution to Outcome

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

1 Describe the basic nature of flow in open channels, analyze the behaviour of flow and apply basic theories to design the optimum channel sections.

2 Demonstrate the energy concepts in open channel and its practical applications.

3 Apply dynamic equation for Gradually varied flow (GVF) and evaluate water profiles at different conditions in prismatic channels.

4 Differentiate between GVF and Rapidly Varied Flow (RVF), analyze hydraulic jump in open channel and its importance.

5 Explain the spatially varied flow and classify water profiles.

6 Discuss the temporal variations of flow in GVF and RVF in open channel.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

1 Flow in Open channels: K. Subramanya, Tata Mc Graw -Hill Publishing Co. Ltd., New Delhi
2 Flow through Open channels: Rajesh Srivastava, Oxford University Press
3 Flow through Open channels: K. G. Ranga Raju, Tata Mc Graw -Hill Publishing Co. Ltd., New Delhi
4 Fluid Mechanics and Hydraulics: Dr S.K. Ukarande, Ane's Books Pvt. Ltd., (Revised Version 2012)
5 Hydraulics & Fluid Mechanics: Modi P.N. & Seth S.M, Standard book house, New Delhi

Reference Books:

1 Open channel Hydraulics: Chow, V.T., McGraw Hill International, New York
2 Open Channel Flow: Henderson F.M., McGraw Hill International
3 Open Channel Flow: M. Hanif Chaudhry, Prentice Hall of India.
4 Open channel Hydraulics: French, R.H., McGraw Hill International

Semester-VI

Course Code	Course Name	Credits
CEDLO6016	Department Level Optional Course - 1 Computational Structural Analysis	03

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

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

Rationale

This subject deals with the conceptual applications of principles of mechanics of rigid and deformable bodies in Structural Engineering.

Objectives

1 To understand basic concepts of Matrix Methods of Structural Analysis and application of approximation techniques (Numerical Methods) in analysis of Structural Member

2 To analyze the behavior of structural members viz beams/plane trusses/ continuous beams/ portal frames

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Basic concepts of structural analysis and methods of solving simultaneous equations**		**04**
	1.1	Introduction, Types of framed structures	
	1.2	Static and Kinematic Indeterminacy, Equilibrium equations	
	1.3	Compatibility conditions, principle of superposition, Energy principles, Equivalent joint loads	
	1.4	Methods of solving linear simultaneous equations- Gauss elimination method, Cholesky method and Gauss- Seidel method.	

2	**Fundamentals of Flexibility and Stiffness Methods**		**07**
	2.1	Concepts of stiffness and flexibility	
	2.2	Local and Global coordinates	
	2.3	Development of element flexibility and element stiffness matrices for truss, beam and grid elements	
	2.4	Force- transformation matrix	
	2.5	Development of global flexibility matrix for continuous beams, plane trusses and Rigid plane frames	
	2.6	Displacement- transformation matrix, Development of global stiffness matrix for continuous beams, plane trusses and rigid plane frames.	
3	**Analysis Using Flexibility Method (Including Secondary Effects)**		**07**
	3.1	Continuous beams, plane trusses and rigid plane frames	
4	**Analysis Using Stiffness Method (Including Secondary Effects)**		**07**
	4.1	Continuous beams, plane trusses and rigid plane frames	
5	**Direct stiffness Method**		**07**
	5.1	Stiffness matrix for truss element in local and global coordinates	
	5.2	Analysis of plane trusses	
	5.3	Stiffness matrix for beam element	
	5.4	Analysis of continuous beams and orthogonal frames.	
6	**Finite Element Method**		**07**
	6.1	Historical Background – Mathematical Modeling of field problems in Engineering	
	6.2	Governing Equations – Discrete and continuous models	
	6.3	Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value	
	6.4	Basic concepts of the Finite Element Method.	
	6.5	One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics.	
		Total	**39**

Contribution to Outcome

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

1. Formulate force displacement relation by flexibility and stiffness method
2. Analyze the plane trusses, continuous beams and portal frames by transformation approach
3. Analyze the structures by direct stiffness method
4. Explain the basics of finite element formulation.
5. Apply finite element formulations to solve one dimensional Problems

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

1. Matrix Methods of Structural Analysis, S. S Bhavikatti, WILEY
2. Matrix Analysis of Framed Structures, Weaver, W., and Gere, J.M., CBS Publishers and distributors pvt. Ltd., 2004.
3. Computational Structural Mechanics, Rajasekaran, S., and Sankarasubramanian, G., PHI, New Dehi, 2001.
4. Introductions to Matrix Methods of Structural Analysis, Martin, H, C., McGraw-Hill, New York, 1966.
5. Structural Analysis A Matrix Approach, G. S. Pandit, S. P. Gupta, TATA McGraw Hill
6. Matrix Computer Analysis of Structures, Rubinstein, M.F., Prentice-Hall

Reference Books:

1. Introductory Methods of Numerical Analysis, S S. Sastry, ASIN : 8120345924, Publisher-Prentice Hall India Learning Private Limited.
2. Introduction to the Finite Element Method, Desai Abel, CBS Publishers and distributors
3. Introduction to Finite Elements in Engineering, Chandrupatala, Belugundu, Pearson Education Publisher : Pearson; 4th edition (20 December 2011)
4. Numerical Methods for Engineers, Steven Chapra, Tata McGraw Hill

Semester-VI

Course Code	Course Name	Credits
CEDLO6017	Department Level Optional Course -2 Traffic Engineering and Management	03

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

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

Rationale

Traffic Engineering Management follows the Transportation Planning and is the specialized branch of the Highway Engineering, which introduces the concepts of characterizing traffic, various modeling approaches, and design of facilities to control and manage traffic. A key feature of the course is that it is well connected with the current design and analysis practice stipulated in national standards, and manuals. Therefore, it deals with the application of scientific principles, tools, techniques and findings for safe, rapid, economical and efficient movement of people and vehicles.

Objectives

1 To understand the concepts of traffic characteristics, traffic surveys to be conducted for planning any transportation network or judging the adequacy of the existing one

2 The application of various statistical tools to the analysis of the large data base emerging out of extensive traffic surveys and transportation and traffic planning.

3 To understand the concept of various features of the intersection infrastructures, their necessity, pros and cons, design or planning principles and subsequently, to design / plan the features such as channelization, island, speed change lanes and parking facility.

4 To understand the concept of highway capacity and such other components such as Passenger Car Unit and Level of Service affecting the Capacity; and Speed- Flow- Density Relationship and various theories describing these relationships.

5 To understand the importance of Highway Safety and implementation of Traffic System Management (TSM) Measures and subsequent to study the various Traffic Control Devices and aspects of Highway Lighting.

6 To explore the future of traffic engineering in the form of Intelligent Transportation system

Detailed Syllabus			
Module	**Course Module / Contents**		**Periods**
1	**Traffic Characteristics and Surveys**		**03**
	1.1	Scope, Traffic Elements - Characteristics-vehicle, road user and road - Traffic studies-speed & delay, traffic volume, O & D, parking and accidents - Sample size, study methodology - Data analysis & inferences.	
2	**Application of Statistics in Traffic Engineering**		**05**
	2.1	Various probability distributions & their applications - Parameter estimation - Hypothesis testing - Random variables	
	2.2	Estimation and analysis of simple regression models - Correlation coefficients - Analysis of correlation coefficients	
	2.3	Application of queuing theory as applied to traffic flow problems for study state conditions	
3	**Intersection Design**		**10**
	3.1	Types of intersections - Conflict diagrams –Control hierarchy- Design of rotaries (Indo-HCM 2017) & at-grade intersections – Signal design as per IRC:93- Grade separated intersections & their warrants, coordination of signals, types of area traffic control	
4	**Traffic Flow Theory**		**10**
	4.1	Measurement, microscopic and macroscopic Study of Traffic Stream Characteristic -Flow, Speed and Density; pace – Time diagram, Headways, Speeds, Gaps and Lags; gap acceptance. Fundamental Equation of Traffic Flow, Speed-Flow-Density Relationships, Shock Wave Theory Passenger's car units, Factors affecting PCU and methods to determine PCU, level of service, factor affecting capacity and level of service. Capacity and level of service suggested for different road facilities as discussed in Indo-HCM 2017, review of flow density speed studies, Light hill and Whitham's theory, fundamentals of traffic stimulation modeling.	
5	**Traffic Management and Road safety Audit**		**07**
	5.1	Various measures for traffic systems management and travel demand management-Congestion management -cost effective Management, their scope, relative merits and demerits. (Pedestrians and Cyclist Management) (IRC SP:55-2014)	
	5.2	Highway Lighting: Important definitions, law of illumination, discernment by artificial lighting, mounting height, spacing, lantern arrangements, types of lamps, lighting of some important highway structures.	
	5.3	Accidents: Accident cause, recording system, analysis and	

		preventive measures, accident cost, alternative methodologies for calculation.	
	5.4	Road Safety Audit: Global & Local perspective – Road safety issues – Road safety programmers – Types of RSA, planning, design, construction & operation stage audits – Methodology – Road safety audit measures, road safety audit process as per IRC: SP-88-2010	
6	**Intelligent Transportation System**		**04**
	6.1	Overview of ITS implementations in developed countries, ITS in developing countries. Study of IRC: SP-110-2017	
	6.2	Historical Background, Benefits of ITS – Introduction to Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), Traffic control and monitoring aspects.	
	6.3	Application of ITS: Advanced Traffic Management Systems (ATMS) Advanced Vehicle Control Systems (AVCS), Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS), Automated Highway Systems	
		Total	**39**

Contribution to Outcome

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

1 Understand different characteristics of the road users and vehicles from their consideration and view point in the traffic engineering and transportation planning.
2 Conduct different traffic surveys, analyzing the data collected as a part of such studies and interpreting it with the help of the different statistical models.
3 Explain the concepts of PCU and LOS, their implication in determination of the capacity using Speed-Flow-Density relationships.
4 Discuss the aspects associated with road safety, its audit and different TSM measures.
5 Discuss transportation planning and ascertain the financial viability of any transportation network in the inception stage itself.
6 Improve the effectiveness and efficiency of transportation systems through advanced technologies in Information systems and communication.

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

1 Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2002.

2 Srinivasa Kumar .R ,Introduction to Traffic Engineering,The Orient Blackswan;south Asian Edition,2018.

3 Chakroborty P., Das N., Principles of Transportation Engineering, PHI,New Delhi,2003

4 Khanna S.K., Justo C.E.G., Highway Engineering, Nem Chand & Bros., Roorkee, 2001

5 Khisty C J,LallB.Kent; Transportation Engineering-An Introduction, Prentice-Hall,NJ, 2005

6 May, A.D., Traffic Flow Fundamentals, Prentice – Hall, Inc., New Jersey,1990.

7 O'Flaherty C A, Highways- Traffic Planning & Engineering, Edward Arnold, UK

8 Drew, D.R., Traffic Flow Theory and Control, McGraw-Hill, New York.

9 Benjamin J. R., Cornell C. A., Probability Statistics and Decision for Civil Engineers, McGraw-Hill, 1970.

10 Asad J. Khattak , Intelligent Transportation Systems: Planning, Operations, and Evaluation, CRC Press

Reference Books:

1 Transportation Engineering and Planning Papacostas, C. S., Prevedouros, P. D., PHIL earning Pvt. Ltd.

2 Transportation Engineering: Khisty, C.J. and Lall, K.B.; PHI Learning Pvt.Ltd.

3 Introduction to Urban Transport Systems, Planning: Hutchinson, B.G.;McGraw-Hill.

4 Economics of Transportation: Fair and Williams, Harper and Brothers, Publishers, NewYork.

5 Highway Capacity Manual, Transportation Research Board, National Research Council, WashingtonD.C.

6 Relevant IRC Codes amended time to time.

Semester-VI

Course Code	Course Name	Credits
CEDLO6018	Department Level Optional Course -2 Introduction to Offshore Engineering	03

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

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

Rationale

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

Objectives

1 To understand the complexities in offshore construction and obtaining resources from the ocean.
2 To addresses the general engineering concepts that are fundamental to offshore engineering.
3 To understand types of sites and platform structures, key engineering systems and ocean environmental monitoring

Detailed Syllabus

Module	Course Module / Contents		Periods
1	**Introduction:**		05
	1.1	History and current state of the art of offshore structures, Definition of Offshore Structures, Met ocean Engineering: wind, wave and current loads on offshore structures	
2	**Environment & Construction:**		06
	2.1	Offshore environment, Construction and launching, offshore project management,	
3	**Ocean Construction:**		06

	3.1	Types of Platforms: Jackets, Tension Leg Platforms (TLP), Semisubmersibles, Jack-ups, Concrete Gravity, deep water construction in ocean, offshore site investigations	
4	**Offshore Pipelines:**		**06**
	4.1	Hydrostatic, hydrodynamic analysis and structural design	
5	**Buoys and Mooring systems:**		**08**
	5.1	Buoys and Mooring systems Mooring configurations, advantages and disadvantages	
6	**Design Criteria:**		**08**
	6.1	Introduction to probabilistic design, extreme load & strength & fatigue, basics of anchoring and mooring system, riser system, Scaling laws & Model testing, Challenges in Deepwater testing: deep-water installations, constructions challenges.	
		Total	**39**

Contribution to Outcome

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

1 To know various offshore construction methodologies

2 To addresses the general engineering concepts during construction stages.

3 To handle complexities and key engineering systems in ocean environment

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

2 Question 1 will be compulsory and should cover maximum contents of the curriculum.

3 Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

4 Only Four questions need to be solved.

Recommended Books:

1 Subrata K. Chakrabarti (2005): Handbook of offshore engineering Volume–I & II, Elsevier, The Boulevard Langford Lane, Kidlington, Oxford OX5 l 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, 1st Edition, 1993. (TP690.A642 RP2A-LRFD)

4 American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design, 21st ed., 2000. (TP690.A642 RP2A-WSD).

Semester-VI

Course Code	Course Name	Credits
CEL601	Design and Drawing of Steel Structures (Lab)	01

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

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

Course Objectives:

1 To estimate the design loads on steel structures as per IS 875

2 To analyze the member forces by any suitable method.

3 To design the members for axial, flexure and shear forces.

4 To prepare the detailed design report and fabrication drawings by manual or CAD software.

Course Outcomes:

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

1 Calculate dead, live and wind loads on the structure.

2 Analyze the structure by analytical/graphical method.

3 Use steel table for selecting appropriate section.

4 Design the members for various load combinations.

5 Design the bolted and welded connection.

6 Read and Prepare the detailed fabrication drawing and design report.

The Project shall be given to a group of students consisting of not more than10 students.		
List of the Projects		
Schedule	**Detailed Content**	**Lab Session / Hr.**
Project 1	**Design and drawing of steel roof truss for industrial shed should consist of the following items.**	
1st Week	Introduction, problem statement, Calculation of panel point DL, LL, and WL on truss.	02
2nd Week	Analysis of truss by graphical method/ any software and calculation of design loads in members	02
3rd Week	Design of purlins, Principal rafter, Main Tie, Design of remaining members of truss. etc.	02
4th Week	Design of bolted /welded connections and design of sliding and hinged supports including anchor bolts	02
5th Week	To generate/draw fabrication drawings on full imperial size drawing sheet and design report on A4 size pages.	02
6th Week	To generate fabrication drawings and design report including estimation of steel required.	02
Project 2	**Design and drawing of floor beam system for steel building G+1 should consist of the following items**	
7th Week	Introduction, problem statement and to draw grid floor plan.	02
8th Week	Calculation of DL, LL on slab, beams etc. and to analyze frame for BM and SF.	02
9th Week	Calculation of design loads on columns and footing.	02
10th Week	Design of beams, columns and footings.	02
11th Week	Design of beam end and beam-column connections.	02
12th Week	To generate/draw fabrication drawings on Full imperial size drawing sheet and design report on A4 size pages.	02
13th Week	To generate fabrication drawings and design report including estimation of steel required.	02

Assessment:

- **Term Work**

Shall consist of design report and fabrication drawings for the above projects and Site visit report related to this course. Distribution of marks for Term Work shall be as follows:

Project 1+Project 2+ Site visit report : 20 Marks

Attendance : 05 Marks

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

- **End Semester Oral Examination**

Oral Examination will be based on Sketching Examination, Term Work and Entire syllabus

Recommended Books:

1 Design of Steel Structure by N. Subramanian, Oxford University Press, New Delhi.

2 Limit state design of steel structures by S. K. Duggal, McGraw Hill Education (India) Pvt. Limited, New Delhi.

3 Design of steel structure by Limit State Method as per IS: 800 - 2007 by Bhavikatti S. S., I.K. International Publishing House, New Delhi.

4 Design of Steel Structures by K. S. Sai Ram, Pearson Education, New Delhi.

5 Limit state design of steel structures as per IS 800/2007. by S. Kanthimathinathan. I.K. International Publishing House, New Delhi.

6 Relevant Indian Specifications, Bureau of Indian Standards, New Delhi.

Reference Books:

1 Design of Steel Structure by Allen Williams

2 Practical Design of Steel Structure by Karuna Moy Ghosh, Whittles Publishing

3 Structural design and drawing by D. Krishnamurthy, CBS Publishers, New Delhi.

4 Teaching Resources Material for steel structures by INSDAG Kolkata.

Semester-VI

Course Code	Course Name	Credits
CEL602	Water Resources Engineering (Lab)	01

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

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

Course Objectives:

1 To study different irrigation engineering methods and water requirement of crops.

2 To study hydrological cycle, its elements and plotting of hydrographs.

3 To study and calculate discharge from aquifers.

4 To study control level fixation for reservoir, Dams i.e gravity dam, its various components and analysis and suitable conditions of earthen dam and its seepage analysis.

5 To study importance of silt theories and its design considerations.

6 To study Canal headwork, its distribution system and design of canal structures.

Course Outcomes:

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

1 Classify various techniques of water distribution and compute water requirement of crops.

2 Discuss in detail about hydrological process and interpret plotting of hydrographs.

3 Apply their knowledge on well hydraulics and compute discharge from an aquifer.

4 Classify and describe various hydraulic structures such as dams and carry out its analysis for structural stability.

5 Compare different silt theories related to irrigation channel and design the same.

6 Identify and classify different canal head works - its distribution system and canal structures.

List of Experiments (Minimum Five)		
Module	**Detailed Content**	**Lab Session / Hr.**
Assignment		
1	Assignment no 1: Irrigation projects in India and Numerical based Water requirement of crops.	02
2	Assignment no 2: Numerical based on missing data, hydrographs.	02
3	Assignment no 3: Numerical based on yield of aquifer.	02
4	Assignment no 4: Numerical based on stability of gravity dam, seepage line (earthen dam)	02
5	Assignment no 5: Numerical based on Silt Theories	02
6	Assignment no 6: Case study on different canals in India and abroad.	02
Model Preparation (if possible, prepare any one model from below suggested topic)		
1	Prepare a model for any one water distribution technique referring to introductory chapter.	06
2	Prepare model for Dam (Gravity or Earthen Dam).	

Assessment:

- **Term Work**

Comprises of Assignments which has to be submitted by each student individually and preparation of model can be worked out in group of 6 members each.

Distribution of marks for Term Work shall be as follows:

Assignments : 20 Marks

Attendance : 05 Marks

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

- **End Semester Oral Examination**

Pair of Internal and External Examiner should conduct oral examination.

Reference Books:

1 Irrigation and Water Power Engineering: B.C. Punmia, PandeB.B.Lal, A.K Jain. Laxmi Publications Pvt, Ltd. New Delhi.

2 Irrigation Engineering and Hydraulic Structures: S.K. Ukarande, Ane Books Pvt. Ltd. ISBN-9789383656899.

3 Irrigation Water Resources and Water Power Engineering: P.N. Modi, Standard Book House, Delhi, ISBN 978-81-87401-29-0.

4 Irrigation Engineering and Hydraulics Structures: S. K. Garg, Khanna Publishers. Delhi.

5 Design of Irrigation Structures: S. K. Sharma, S. Chand and Co.

6 Theory and Design of Irrigation Structures: R. S. Varshney and R, C. Gupta, Nem Chand

7 Engineering for Dams, Vol. I to III: Crager, Justin and Hinds, John Wiley

9 Design of Small Dams: USBR.

10 Hydro Power Structures: R. S. Varshney, Nem Chand and Bross.

11 Concrete Dams: R. S. Varshney, Oxford and IBH Publishing Co.

Semester-VI

Course Code	Course Name	Credits
CEL603	Geotechnical Engineering-II Lab	01

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

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

Course Objective:

1 To study consolidation characteristics of soil.

2 To study and examine shear strength parameters of soil.

3 To Study and determine the strength of sub-grade soil.

4 To Study and determine swelling pressure of soil.

5 To gain the knowledge of stress distribution in soil.

6 To gain the knowledge of various geotechnical software.

Course Outcomes:

At the end of the course Students will be able to

1 Determine consolidation parameters such as coefficient of compressibility, coefficient of volume change, coefficient of consolidation.

2 Determine cohesion and angle of shearing resistance for various soil types.

3 Determine the CBR value of soil for pavement design.

4 Determine swelling pressure of soil.

5 Understand the concept of stress distribution in soils due to vertically applied load.

6 Solve design problems using geotechnical software.

List of Experiments (Minimum Five)

Module	Detailed Content	Lab Session Hrs.
1	Determination of pre-consolidation pressure and coefficient of consolidation from one dimensional consolidation test	02

2	Determination of shear strength parameters using direct shear test	02
3	Determination of shear strength parameters using unconsolidated undrained tri-axial compression test	02
4	Determination of undrained cohesion using unconfined compression test	02
5	Determination of shear strength of soft clays by vane shear test	02
6	Determination of CBR value using CBR test	02
7	Determination of swelling pressure of clays	02

Assignment:

a) Term Work Assessment
Assignments should contain at least 15 numerical problems covering the entire syllabus.

b) One assignment shall be given on either vertical stress distribution in soils or a design problem using geotechnical engineering software. The teacher is expected to impart the knowledge to the students about the concept of stress distribution of soils or design problem using software. The questions related to stress distribution in soils or design problem using software shall **NOT** be asked in the theory examination. However, it shall be treated as a part of term work submission. It shall preferably cover the following points:

- Vertical stress distribution in soils: Estimation of vertical stress in soil due to surface load using Boussinesq equation.

OR

- Design problem using software: Introduction to any geotechnical software like Geo 5, PLAXIS, FLAC, MIDAS GTS-NX etc.

Distribution of Term Work Marks

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	15 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

- End Semester Oral Examination : 25 marks

Reference Books:

1 Engineering Soil Testing: Shamsher Prakash, P.K. Jain; Nem Chand & Bros

2 Soil Testing for Engineers: William T. Lambe; John Wiley and Sons, Inc.

3 Soil Mechanics Laboratory Manual: Brij Mohan DAS; Oxford University Press Inc.

4 Soil Mechanics in Engineering Practice: Karl Terzaghi, Ralph B. Peck, Gholamreza Mesri; John Wiley and Sons, Inc.

5 Soil Mechanics and Foundations: Dr. B. C. Punmia, Ashok Kumar Jain, Arun Kumar; Laxmi Publications

6 Soil Mechanics in Theory and Practice: Alam Singh; Asia Publishing House

7 Soil Mechanics and Foundation Engineering: V. N.S. Murthy; Saitech Publications

8 Relevant Indian Standard Specifications Code: BIS Publications; New Delhi

Semester-VI

Course Code	Course Name	Credits
CEL604	Environmental Engineering (Lab)	01

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

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

Course Objectives:

1 To analyse engineering skill related to water and wastewater sample.

2 To apply decision related to treatment of water and wastewater based on standards.

3 To understand the fundamental characteristics of municipal solid waste.

4 To acquire knowledge on the severity of air pollution and suggest remedies and preventive measures.

5 To understand the basic concepts of noise and its measurement.

Course Outcomes:

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

1 Impart the knowledge on quality or characteristic of water and wastewater sample.

2 Interpret the required treatment for water and wastewater based on standards and norms.

3 Impart the knowledge on quality of solid waste.

4 Measure the concentration of particulate matters, dust and dispersed pollutants in air.

5 Inspect the levels of noise and interpret the results.

List of Experiments (Any eight to be performed)		
Module	**Detailed Content**	**Lab Session / Hr.**
1	Determination of pH of water/ sewage sample /solid waste.	02
2	Determination of Turbidity in water sample.	02
3	Determination of Total Solids, suspended solids, dissolved solids, volatile solids.	02
4	Determination of chlorides.	02
5	Determination of Optimum dose of coagulant by using Jar Test.	02
6	Determination of Dissolved Oxygen.	02
7	Determination of Residual chlorine	02
8	Determination of air quality using High Volume air Sampler.	02
9	Determination of Level equivalent of Noise	02
10	Determination of Bio Chemical Oxygen Demand of sewage sample	02
11	Determination of Chemical Oxygen Demand of sewage sample.	02
12	Determination of moisture content of solid waste.	02

Assessment:

- **Term Work**

Including Laboratory Work and Assignments both, Distribution of marks for Term Work shall be as follows:

Laboratory Work	:	15 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

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

- **End Semester Oral Examination**

Oral exam will be based on experiments performed, site visit and theory syllabus.

Reference Books:

1 Water Supply Engineering: S. K. Garg, Khanna Publication.
2 Environmental Engineering Vol II: Garg, S. K., Khanna Publishers New Delhi.
3 Water Supply Engineering: P.N. Modi, Rajsons Publication.
4 Environmental Engineering: *B. C. Punmia*, Laxmi Publications, New Delhi.
5 Solid waste management in developing countries: A.D. Bhide and B.B. Sundaresan.
6 CPHEEO Manual on Water Supply and Treatment.
7 CPHEEO Manual on Sewage and Treatment.

Semester-VI

Course Code	Course Name	Credits
CEL605	Skill Based Lab Course-III	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

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

Course Objectives:

1. To Provide hands on training on analysis, modelling and design of R. C. C. Framed structure and Steel structure.
2. To prepare the database and perform its statistical analysis using relevant software.
3. To understand and apply the basic functions of excel for data analysis, preparation of programs and generation of reports having mathematical and pictorial representation.
4. To design reliable and sustainable transportation systems.
5. To evaluate the demand of water for given population and create the proper distribution system.
6. To Apply the basic knowledge of various computer languages to create the programme pertaining to civil engineering domain.

Course Outcomes:

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

1. To understand the functions involved various softwares related to civil engineering field.
2. To perform different functions of the software related to analysing modelling and designing the structure, creation of database and its analysis.
3. To describe and represent the data obtained from site, experimental work in various formats as per industrial requirements
4. To import road geometric design into the software as well as relate with the design standards applied into the software.
5. To design the effective distribution network system for the distribution of water resources.
6. To apply the knowledge to create the programme in excel and various computer languages for solving problems pertaining to civil engineering field.

List of Experiments (Minimum Eight)		
Module	**Detailed Content**	**Lab Session / Hr.**
Analysis, Modelling and Design of structure using professional software		**15**
1	Introduction to structural engineering software. Study of basic commands and tools.	03
2	Analysis of determinate and in-determinate structure. Extraction of shear force and bending moment diagram for given structure manually as well using software	03
3	Developing a model of simple plan of a building (square or rectangular)	03
4	Analysis of frames – R. C. C. framed structure	03
5	Analysis of frames – Steel structure	03
Preparation and analysis of database using open-source software		**03**
6	Introduction to statistical software – Basic function required for preparing database, statistical analysis of the data and its representation	03
Excel		**15**
7	Introduction to Excel – Basic function required for preparing database, statistical analysis of the data and its graphical representation a. Creation of database of result obtained from Traffic volume survey and its analysis b. Creating database of results obtained from laboratory experiments and its analysis	03
8	Preparation of programme using various functions in excel or any other relevant exercise in civil engineering field 1. Mix design of concrete 2. Design of pavement 3. Design of structural members	03
9	Preparation of checklist for various items of work in building construction for quality control, Preparation of various reports like Daily progress report, Daily Labour report, Weekly progress report, Weekly Labour report, Geotechnical reports, Audit reports	03
10	Use of transportation engineering related software for creation of contour, creation of cross section, setting horizontal and vertical alignment and calculation of cut and fill	03
11	Use of open-source software for designing and simulation of water distribution network	03
Programming using open-source software C or C++ or java or python		**06**
12	Introduction to programming software, Basics commands and tools for development of programme related to civil engineering field	03
13	Programming for Civil Engineers with content related to any domains of Civil Engineering problem solving using programming software.	03

Assessment:

- **Term Work**

Including Laboratory Work comprising of minimum 5 software generated reports/sheets/program outputs along with minimum 5 assignments or reports, distribution of marks for Term Work shall be as follows:

Laboratory Work	:	10 Marks (comprising of min. 5 software generated sheets/program outputs)
Assignments	:	10 Marks (comprising of min. 5 Reports)
Attendance	:	05 Marks

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

End Semester Oral Examination

Oral exam will be based on Laboratory Work performed.

Reference Books:

1 Software manuals

2 IS 456, IS 800

3 Refereed Journal papers on Software applications

4 Manual on Water Supply and Treatment, C. P. H. E. E. O., Ministry of Urban Development, Government of India, New Delhi

5 The 'C' Programming Language, B.W Kernighan & D.M Ritchie, Prentice Hall of India

6 Statistics for Managers, Using Microsoft Excel, 8th Edition, David M., Levine, Pearson India Education service Pvt ltd.

Recommended Books:

1 Excel with Microsoft Excel: Comprehensive & Easy Guide to Learn Advanced MS Excel Paperback – 1 January 2019 by Naveen Mishra (Author); Publisher:Penman Books; Publication date: 1 January 2019; ISBN-10: 9389024153; ISBN-13: 978-9389024159

2 Structural Modeling, Analysis & Design Using Staad Pro Software Paperback – 15 October 2015 by Vignesh Kumar M (Author); Publisher: LAP Lambert Academic Publishing; Genre: Business & Economics; ISBN: 9783848447671, 9783848447671

3 Discovering Statistics Using SPSS for Windows: Advanced Techniques for the Beginner; By Andy P. Field; Publisher:Sage Publications; ISBN:9780761957553, 0761957553

4 Quality Management in Construction Projects; By Abdul Razzak Rumane; Copyright Year 2018; ISBN 9780367890032; Published December 10, 2019 by CRC Press

5 Introduction to Machine Learning with Python: A Guide for Data Scientists Paperback – 7 October 2016; by Andreas C. Mueller (Author), Sarah Guido (Author); ISBN-10: 1449369413; ISBN-13: 978-1449369415, 1st Edition; Publisher O 'Reilly

Semester-VI

Course Code	Course Name	Credits
CEM601	Mini Project -2B	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	03	-	-	1.5	-	1.5

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

Rationale

Civil engineers deal with many challenges on daily basis. The civil engineering industry's growth has been need based and society centric. Computers and IT systems have touched almost every part of our lives and inter-disciplinary approach is way of life ahead. Mumbai University proposed Mini projects in the syllabus so that the budding civil engineers can connect with the world outside their textbooks and have the idea of future course. The Mini project should actually provide solution to a typical problem after a brainstorming and in a stipulated period. The solutions based on software, development of computer application, or IT systems based on artificial intelligence or IOT are expected from civil engineering students. The competitions ahead will give students the experience of the civil engineering industry's real-world problems and make students brainstorm ideas, learn, and explore the civil engineering industry.

Course Objectives:

1 To recognize societal problems and convert them into a problem statement by understanding of facts and ideas in a group activity. (BTL-2)

2 To deal with new problems and situations by applying acquired knowledge, facts, techniques and rules in a different way. (BTL-3)

3 To examine and break information into parts, by analyzing motives or causes. (BTL-4)

4 To learn evaluating information, validity of ideas and work based on a set of criteria. (BTL-5)

5 To create solutions by compiling information together in a novel way. (BTL-6)

6 To design software based model, application or IT system by combining elements in a new pattern or proposing new solutions. (BTL-6)

Course Outcomes:

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

1 Identify problems based on societal /research needs and formulate a solution strategy.

2 Apply fundamentals to develop solutions to solve societal problems in a group.

3 Analyze the specific need, formulate the problem and deduce the interdisciplinary approaches, software-based solutions and computer applications.

4 Develop systematic flow chart, evaluate inter disciplinary practices, devices, available software, estimate and recommend possible solutions.

5 Draw the proper inferences from available results through theoretical/experimental/simulations and assemble physical systems.

6 Create devises or design a computer program or develop computer application.

- **Guidelines for Mini Project -2**B

  Expected outcome is Software based, "**A Computerized Model/ A software/ A computer program, an IOT application or A Computer or Mobile based application** ".

  Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.

  Students should find 'List of Mini project- 2B problems' in University web portal www.mu.ac.in, and in consultation with faculty supervisor/head of department/internal committee of faculties select the title.

  Students shall submit implementation plan in the form of Gant/PERT/CPM chart, which will cover weekly activity of mini project.

  A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

  Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

  Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

  Students shall convert the best solution into A Computerized Model/ a software/ A computer program, an IOT application or A Computer or Mobile based application using various components of their domain areas and demonstrate.

  The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

  With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it ispreferable that Students come out with original solution.

  However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a

completely new project idea in even semester. This policy can be adopted on case-by-case basis.

List of approved problems for Mini Project -2B:	
S501:	Development for Mobile App for Smart Traffic Management System Using Internet of Things
S502:	Development for Mobile App for IoT based smart traffic signal monitoring system using vehicle Count.
S503:	Development of (AI Based) software or mobile App. To identify quantity of (bricks, pipes, bars etc.) from photograph.
S504:	Development of (AI Based) software or mobile App. To identify size of cracks in distressed structure from coin aimed photograph.
S505:	Development of (AI Based) software or mobile App. To identify size of cracks in distressed structure.
S506:	Development of (AI Based) software or mobile App. For Assessment of Irrigation Water Quality Index.
S507:	Development of (AI Based) software or mobile App. For Ground Water Quality monitoring in industrial zone.
S508:	Development of (AI Based) software or mobile App Advanced Earthquake Resistant Techniques
S509:	Development of Remote Monitoring System For Civil Engineering projects.
S510:	Application of Geographic Information system using Quantum GIS software.
S511:	Development of (AI Based) software or mobile App for Building Information Modelling using ArchiCAD/ Revit architecture software.
S512:	Development of (AI Based) software or mobile App Digitization of Slump cone Test.
S513:	Development of (AI Based) software or mobile App Digitization of other mechanical Tests.
S514:	Development of (AI Based) software or mobile App Civil Engineering quantity calculator.
S515:	Development of (AI Based) software or mobile App Digitization of Non-destructive testing of concrete-various methods.
S516:	Development of (AI Based) software or mobile App Mapping of area using Total Station and plotting the same on 3-d drafting.
S517:	Preparation of Excel VBA sheet for solving Survey, Soil Mechanics, Structural Analysis problems.
S518:	Development of (AI Based) software or mobile App Smart street lights and fault location monitoring in the cloud over IoT
S519:	Development of (AI Based) software or mobile App IOT based smart irrigation system
S520:	Development of (AI Based) software or mobile App Smart cities: Traffic data monitoring over IoT for easy transportation/alternative route selection
S521:	Development of (AI Based) software or mobile App Dam gate level monitoring for water resource analysis and dam gate control over IoT.
S522:	Development of (AI Based) software or mobile App Smart colony: RFID based gate security system, street lights, and water pump automation.
S523:	Development of (AI Based) software or mobile App Agriculture automation using GSM (soil moisture level control and motor control)

(This is tentative list, this list will be continuously updated by contributions from faculty, industry and alumni.)

Guidelines for Assessment of Mini Project:

- **Term Work**

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below:

Marks awarded by guide/supervisor based on log book	:	10 Marks
Marks awarded by review committee	:	10 Marks
Quality of Project report	:	5 Marks

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

- **Assessment criteria of Mini Project:**

Mini Project shall be assessed based on following criteria:

Quality of survey/ need identification

Clarity of Problem definition based on need.

Innovativeness in solutions

Feasibility of proposed problem solutions and selection of best solution

Cost effectiveness

Societal impact

Innovativeness

Cost effectiveness and Societal impact

Full functioning of working model as per stated requirements

Effective use of skill sets

Effective use of standard engineering norms

Contribution of an individuals as member or leader

Clarity in written and oral communication

In one year, project, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.

In case of half year project all criteria in generic may be considered for evaluation of performance of students in mini project.

- **Guidelines for Assessment of Mini Project Practical/Oral Examination:**

  Report should be prepared as per the guidelines issued by the University of Mumbai.

  Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years and approved by head of Institution.

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

- **Mini Project shall be assessed based on following points:**

  Quality of problem and Clarity

  Innovativeness in solutions

  Cost effectiveness and Societal impact

  Full functioning of working model as per stated requirements

  Effective use of skill sets

  Effective use of standard engineering norms

  Contribution of an individuals as member or leader

  Clarity in written and oral communication