Item No: 125
AC- 23/7/2020

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Civil Engineering

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

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

Under

FACULTY OF SCIENCE & TECHNOLOGY

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

Item No: -125
AC- 23/7/2020

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Civil Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	**U.G.**
7	Pattern	**Semester**
8	Status	**New**
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date

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

Dr Anuradha Muzumdar
Dean
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University of Mumbai

Preamble

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

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

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

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

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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 sessions, which was attended by more than 40 members from different affiliated Institutes of the University, who are either Heads of Departments or their senior representatives from the Department of Civil Engineering. The PEOs finalized for the undergraduate program in Civil Engineering are listed below;

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

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

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

Board of Studies in Civil Engineering, University of Mumbai

1. Dr. S. K. Ukarande:	Chairman
2. Dr. K. K. Sangle:	Member
3. Dr. S. B. Charhate:	Member
4. Dr. A. R. Kambekar:	Member
5. Dr. R. B. Magar:	Member
6. Dr. Seema Jagtap:	Member

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from **2020-2021**)

Semester - III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC301	Engineering Mathematics-III	3	-	1	3	-	1	4
CEC302	Mechanics of Solids	4			4			4
CEC303	Engineering Geology	3			3			3
CEC304	Architectural Planning & Design of Buildings	2	-	-	2	-	-	2
CEC305	Fluid Mechanics- I	3	-	-	3	-	-	3
CEL301	Mechanics of Solids	-	2	-	-	1	-	1
CEL302	Engineering Geology	-	2	-	-	1	-	1
CEL303	Architectural Planning & Design of Buildings	-	2	-	-	1	-	1
CEL304	Fluid Mechanics- I	-	2	-	-	1	-	1
CEL305	Skill Based Lab Course-I		3		-	1.5		1.5
CEM301	Mini Project – 1 A	-	$3^{\$}$	-	-	1.5	-	1.5
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Examination Scheme									
Course Code	**Course Name**	**Internal Assessment**			**End Sem Exam**	**Exam Duration (Hrs.)-**	**Term Work**	**Prac. /Oral**	**Total**
		Test I	Test II	Avg.					
CEC301	Engineering Mathematics-III	20	20	20	80	3	25	-	125
CEC302	Mechanics of Solids	20	20	20	80	3	-	-	100
CEC303	Engineering Geology	20	20	20	80	3	-	-	100
CEC304	Architectural Planning & Design of Buildings	20	20	20	80	3	-	-	100
CEC305	Fluid Mechanics- I	20	20	20	80	3	-	-	100
CEL301	Mechanics of Solids	-	-	-	-	-	25	25	50
CEL302	Engineering Geology	-	-	-	-	-	25	25	50
CEL303	Architectural Planning & Design of Buildings	-	-	-	-	-	25	25	50
CEL304	Fluid Mechanics- I	-	-	-	-	-	25	25	50
CEL305	Skill Based Lab Course-I	-	-	-	-	-	50	-	50
CEM301	Mini Project – 1 A	-	-	-	-	-	25	25	50
	Total			**100**	**400**	**-**	**200**	**125**	**825**

Semester – IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC401	Engineering Mathematics - IV	3	--	1	3	-	1	4
CEC402	Structural Analysis	4	--	-	4	-	-	4
CEC403	Surveying	3	--	-	3	-	-	3
CEC404	Building Materials &Concrete Technology	3	--	-	3	-	-	3
CEC405	Fluid Mechanics-II	3	-	-	3	-	-	3
CEL 401	Structural Analysis	--	2	-	-	1	-	1
CEL 402	Surveying	--	3	-	-	1.5	-	1.5
CEL 403	Building Material Concrete Technology	--	2	-	-	1	-	1
CEL 404	Fluid Mechanics-II	--	2			1		1
CEL 405	Skill Based lab Course-II	--	2	-	-	1	-	1
CEM401	Mini Project – 1 B	--	$3^{\$}$	-	-	1.5	-	1.5
Total		**16**	**14**	**1**	**16**	**7**	**1**	**24**

Examination Scheme									
Course Code	**Course Name**	**Internal Assessment**			**End Sem Exam**	**Exam Duration (Hrs.)-**	**Term Work**	**Prac. /Oral**	**Total**
		Test I	Test II	Avg.					
CEC 401	Engineering Mathematics - IV	20	20	20	80	3	25	-	125
CEC 402	Structural Analysis	20	20	20	80	3	-	-	100
CEC 403	Surveying	20	20	20	80	3			100
CEC 404	Building Materials & Concrete Technology	20	20	20	80	3	-	-	100
CEC 405	Fluid Mechanics-II	20	20	20	80	3	-	-	100
CEL 401	Structural Analysis						25	25	50
CEL 402	Surveying						50	25	75
CEL 403	Building Materials & Concrete Technology	-	-	-	-	-	25	25	50
CEL 404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL 405	Skill Based lab Course-II	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1 B	-	-	-	-	-	25	25	50
	Total			**100**	**400**	**-**	**225**	**125**	**850**

Semester- III

Course Code	Course Name	Credits
CEC 301	Engineering Mathematics-III	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	01	03	-	01	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem. Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	25	-	-	125

Pre-requisite: Engineering Mathematics-I,

Engineering Mathematics-II,

Course Objectives:

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills.
3. To familiarize with the concept of complex variables, C-R equations with applications.
4. To study the application of the knowledge of matrices and numerical methods in complex engineering problems.

Course Outcomes: Learner will be able to….

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.
6. Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

Module	Detailed Contents	Hrs.
01	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform, 1.2 Laplace Transform (L) of Standard Functions like e^{at}, $sin(at), cos(at)$, $sinh(at)$, $cosh(at)$ and t^n $, where\ n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by t, Division by t, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation. **Self-learning topics:** Heaviside's Unit Step function, Laplace Transform. of Periodic functions, Dirac Delta Function.	07 Hrs.
02	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivative 2.2 Partial fractions method & first shift property to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	06 Hrs.
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof) 3.2 Fourier series of periodic function with period 2π and $2l$, 3.3 Fourier series of even and odd functions 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, orthogonal and orthonormal set of functions, Fourier Transform.	07Hrs.
04	**Module: Complex Variables:** 4.1 Function $f(z)$ of complex variable, limit, continuity and differentiability of $f(z)$, Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof), 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof) 4.3 Milne-Thomson method to determine analytic function $f(z)$ when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given.	07Hrs.

	4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations	
05	**Module: Matrices:** 5.1 Characteristic equation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors. (**No theorems/ proof**) 5.2 Cayley-Hamilton theorem (without proof): Application to find the inverse of the given square matrix and to determine the given higher degree polynomial matrix. 5.3 Functions of square matrix 5.4 Similarity of matrices, Diagonalization of matrices **Self-learning Topics:** Verification of Cayley Hamilton theorem, Minimal polynomial and Derogatory matrix & Quadratic Forms (Congruent transformation & Orthogonal Reduction)	06 Hrs.
06	**Module: Numerical methods for PDE** 6.1 Introduction of Partial Differential equations, method of separation of variables, Vibrations of string, Analytical method for one dimensional heat and wave equations. (only problems) 6.2 Crank Nicholson method 6.3 Bender Schmidt method **Self-learning Topics:** Analytical methods of solving two and three dimensional problems.	06 Hrs.
	Total	39

Term Work:

General Instructions:

1 Batch wise tutorials are to be conducted. The number of student'sperbatch should be as per University pattern for practicals.

2 Students must be encouraged to write at least 6 class tutorials on entire syllabus.

3 A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

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

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

References:

1 Engineering Mathematics, Dr. B. S. Grewal, KhannaPublication
2 Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited,
3 Advanced Engineering Mathematics, R. K. Jain and S.R.K. Iyengar, Narosapublication
4 Advanced Engineering Mathematics, H.K. Das, S. Chand Publication
5 Higher Engineering Mathematics B.V. Ramana, McGraw HillEducation
6 Complex Variables and Applications, Brown and Churchill, McGraw-Hilleducation,
7 Text book of Matrices, Shanti Narayan and P K Mittal, S. ChandPublication
8 Laplace transforms, Murray R. Spiegel, Schaum's OutlineSeries

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Semester- III								
Course Code			Course Name				Credits	
CEC 302			Mechanics of Solids				4	
Contact Hours				Credits Assigned				
Theory	Practical	Tutorial		Theory	Practical	Tutorial	Total	
4	-			4	-	--	4	

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

Rationale

Civil Engineering structures are made using various engineering materials such as steel, concrete, timber, other metals or their composites. They are subjected to force systems resulting into axial forces, bending moments, shear forces, torsion and their combinations. Different materials respond differently to these by getting deformed and having induced stresses. Determination of stress, strain, and deflection suffered by structural elements when subjected to diverse loads is prerequisite for an economical and safe design.

In this course, learners will understand the internal response behavior of material under different force systems. The knowledge of 'Mechanics of Solids' will be foundation of essential theoretical background for the subjects of Structural Analysis and Structural Design.

Objectives

1) To learn stress - strain behavior and physical properties of materials and to compute the Stresses developed and deformation of Elastic members and thin cylinders subjected to internal pressure.
2) To learn to represent graphically the distribution of axial force, shear force and bending moment along the length of statically determinate beams and portal frames.
3) To compute area moment of inertia and to analyze the distribution of shear stress and the flexural (bending) stress across the cross section of structural members.
4) To study circular shafts under the action of twisting moment and to determine the direct and bending stresses in columns and study buckling behavior of centrally and eccentrically loaded columns.
5) To determine principal planes and stresses and strain energy computation in elastic members.
6) To learn the computation of slope and deflection of elastic beams and general theorems used in this computation.

Detailed Syllabus			
Module		**Course Modules / Contents**	**Periods**
1	**Module Name- Stresses and Strains in Elastic members, Spherical and Cylindrical shells**		**(9)**
	1.1	Types of Stresses and Strains, stress-strain curve, different types of Elastic moduli and relationships between them, Poisson's ratio, factor of safety. Bars of varying sections, composite sections, temperature stresses	**6**
	1.2	Thin cylindrical and spherical shells under Internal pressure: Determination of Hoop stress, Longitudinal stress, Shear stress and volumetric strain.	**3**
2	**Module Name- Axial force, shear force and bending moment diagrams for beams and portal frames**		**(9)**
	2.1	Concept of Axial Force, Shear Force and Bending Moment. a) A.F. S.F. and B M Diagrams for statically determinate S S and Cantilever **beams without internal hinges** and for single loading like point load, UDL, UVL or Couple moment. b) A.F. S.F. and B.M. Diagrams for statically determinate **beams with internal hinges** and combination of loading	**6**
	2.2	A.F. S.F. and B.M Diagrams for statically determinate **3-member Portal Frames with or without internal hinges .**	**3**
3	**Module Name- Area Moment of Inertia, Shear stresses and Bending stresses in beams**		**(9)**
	3.1	Area Moment of inertia, Parallel and Perpendicular axis theorem, polar moment of inertia. Radius of gyration. (Rectangular, Triangular, Circular, Semicircular section and their combination) Distribution of shear stress across plane sections Commonly used for structural purposes.	**5**
	3.2	Theory of pure bending, Flexure formula for straight beam, simple problems involving application of Flexure formula, section modulus, moment of resistance, flitch beams.	**4**
4	**Module Name- Torsion in Shafts, Columns**		**(10)**
	4.1	Torsion in solid and hollow circular shafts, shafts with varying cross sections, Shafts transmitting and receiving power at different points. Stresses in Shafts while transmitting power.	**4**
	4.2	Direct and bending stresses in Columns, Core of section.	**6**

		Buckling of Columns, Members subjected to axial loading, concept of buckling, effective length, different support conditions, Euler’s and Rankine’s formula. Concept of Eccentrically loaded columns.	
5	**Module Name- Principal planes and stresses, Strain Energy**		**(8)**
	5.1	General equation for transformation of stress, Principal planes and principal stresses, maximum Shear stress, stress determination by analytical and Graphical method (using Mohr’s circle).	**4**
	5.2	Strain energy due to axial force and impact loads in columns, due to bending in beams, due to torsion of shaft.	**4**
6	**Module Name- Slope and Deflection in Beams , General Theorems**		**(7)**
	6.1	Concept of Slope and Deflection in Beams, Macaulay’s Method for slope and deflection in S S and Cantilever beams subjected to point loads, UDL and couple moments.	**4**
	6.2	General Theorems: Betti and Maxwell’s reciprocal Theorem,, Principle of Superposition, Principle of Virtual work, Castigliano’s theorems.	**3**

Contribution to Outcome

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

1) Evaluate stress - strain behavior of elastic members and thin cylinders subjected to internal pressure.
2) Draw variation of axial force, shear force and bending moment diagram for statically determinate beams and frames.
3) Calculate Moment of Inertia for cross sections and analyse the material response under the action of shear and the effect of flexure (bending).
4) Predict the angle of twist and shear stress developed in torsion and compute direct and bending stresses developed in the cross section of centrally and eccentrically loaded columns.
5) Locate principal planes in members and calculate principal stresses using analytical and graphical method and to calculate strain energy stored in members due to elastic deformation.
6) Evaluate slope and deflection of beams supported and loaded in different ways.

Internal Assessment (20 Marks):

One **Compulsory Class Test,** based on approximately 40% of contents and another on 40% from the remaining content be taken. Average of the two will be considered as IA Marks.

End Semester Examination (80 Marks):

Weightage of each module in end semester examination will be proportional to number of respective lecture

Hours mentioned in the curriculum.

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

Recommended Books:

1. Strength of Materials: *S. Ramamrutham*, Dhanpatrai Publishers.
2. Strength of Materials: *R.K. Rajput*, S. Chand Publications.
3. Mechanics of Materials: Vol-I: *S.B. Junnarkar and H.J. Shah*, Charotar Publications.
4. Strength of Materials: *Subramanian*, Oxford University Press
5. Strength of Materials: *S.S. Rattan*, Tata Mc-Graw Hill, New Delhi
6. Strength of Materials (Mechanics of Materials): *R.S. Lehri and A.S. Lehri*, S.K. Kataria Publishers, New Delhi
7. Strength of Materials: *Dr. V.L. Shah*, Structures Publications, Pune

Reference Books:

8. Mechanics of Materials: *James, M. and Barry J.*; Cengage Learning.
9. Mechanics of Materials: *Andrew Pytel and Jaan Kiusalaas*, Cengage Learning.
10. Mechanics of Materials: *Timoshenko and Gere*, Tata McGraw Hill, New Delhi.
11. Mechanics of Materials: *James M. Gere*, Books/Cole.
12. Strength of Materials: *G.H. Ryder*, Mc-Millan.
13. Mechanics of Materials: *E.P. Popov*, Prentice Hall India (PHI) Pvt. Ltd.
14. Mechanics of Materials: *Pytel and Singer*, Mc-Graw Hill, New Delhi.
15. Strength of Materials: *William A. Nash and Nillanjan Mallick*, Mc-Graw Hill Book Co. (Schaum's Outline Series)

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Semester-III

Course Code	Course Name	Credits
CEC 303	Engineering Geology	3

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

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

Rationale

Engineering geology is an applied geology discipline that involves the collection, analysis, and Interpretation of geological data and information required for the safe development of civil works. The objective of this course is to focus on the core activities of engineering geologists – site characterization, geologic hazard identification and mitigation. Through lectures, labs, and case study examination student will learn to couple geologic expertise with the engineering properties of rock in the characterization of geologic sites for civil work projects.

Understanding of the foundation rocks and structures present in them is of utmost importance for the safety and stability of Civil engineering structures. The study also helps in the assessment of groundwater, oil and gas and mineral resource evaluation.

Objectives

1. To acquire basic knowledge of Geology and to understand its significance in various civil engineering projects.
2. To study minerals and rocks in order to understand their fundamental characteristics and engineering properties.
3. To study structural geology for characterization of site, analysis and report geologic data using standards in engineering practice.
4. To study methods of subsurface investigation, advantages and disadvantages caused due to geological conditions and assessment of site for the construction of civil structures.
5. To study rock mass characterization for the construction of tunnels and assessment of rock as source of ground water.
6. To study the control of geology over the natural hazards and their preventive measures.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1		**Introduction & Physical Geology**	**5**
	1.1	Branches of geology useful to civil engineering, Importance of geological studies in various civil engineering Projects. Departments dealing with this subject in India and their scope of work- GSI, Granite Dimension Stone Cell, NIRM.	
	1.2	Internal structure of the Earth and use of seismic waves in understanding the interior of the earth. Theory of Plate Tectonics.	
	1.3	Weathering types, Erosion and Denudation. Factors affecting weathering and product of weathering (engineering consideration) Superficial deposits and its geological Importance.	
	1.4	Brief study of geological action of wind, glacier and river.	
2		**Mineralogy and Petrology**	**7**
	2.1	Identification of minerals with the help of physical properties, rock forming minerals, megascopic identification of primary and secondary minerals, study of common ore minerals.	
	2.2	Igneous Petrology - Mode of formation, Texture and structure, form of Igneous rocks, Classification of Igneous rocks, study of commonly occurring igneous rocks, Engineering aspect of Granite and Basalt.	
	2.3	Sedimentary Petrology - Mode of formation, Textures, characteristics of shallow water deposits like lamination, bedding, current bedding etc., classification, study of commonly occurring sedimentary rocks and their engineering application.	
	2.4	Metamorphic Petrology - Mode of formation, agents and types of metamorphism, structures and textures of metamorphic rocks, classification and study of commonly occurring metamorphic rocks and their engineering application.	
3		**Structural Geology and Stratigraphy**	**12**
	3.1	Dip and Strike. Outcrop and width of outcrop. Inliers and Outliers. Type of discontinuities in the rocks. **Fold:** Terminology, Classification on the basis of position of axial plane, Criteria for their recognition in field and engineering consideration. **Fault:** Terminology, Classification on the basis of movement of faulted block, Criteria for recognition in field, effects on outcrops and Engineering consideration.	

		Joints & Unconformity: Types and geological importance. Three point problems to determine attitude of the strata	
	3.2	Determination of thickness of the strata with the help of given data.	
	3.3	Geological Maps and their application for civil engineering works, Identification of symbols in maps.	
	3.4	General principles of Stratigraphy, geological time scale, Physiographic divisions of India and their characteristics. Stratigraphy of Deccan Volcanic Province.	
4	**Geological Investigation, study of dam and reservoir site:**		7
	4.1	Required geological consideration for selecting dam and reservoir site. Favorable & unfavorable conditions in different types of rocks in presence of various structural features, precautions to be taken to counteract unsuitable conditions.	
	4.2	Electrical resistivity and Seismic method of geological investigation. Rock Quality Designation and its importance to achieve safety and economy of the projects like dams and tunnels.	
	4.3	Borehole problems and their significance in determining subsurface geology of the area.	
5	**Tunnel Investigation and Ground Water Control**		5
	5.1	Importance of geological considerations while choosing tunnel sites and alignments of the tunnel, safe and unsafe geological and structural conditions.	
	5.2	Geo-mechanics classification (RMR) and its application.	
	5.3	Sources, zones, water table, unconfined, confined and Perched water tables. Factors controlling water bearing capacity of rocks, Pervious and Impervious rocks, Different types of rocks as source of ground water. Artesian well (flowing and non-flowing). Cone of Depression and its use in Civil engineering.	
6	**Geological Disasters and Control Measures**		3
	6.1	Landslides-Types, causes and preventive measures for landslides, Landslides in Deccan region.	
	6.2	Volcano- Central type and fissure type, products of volcano.	
	6.3	Earthquake- Terminology, Earthquake waves, construction and working of seismograph, Earthquake zones of India, elastic rebound theory, Preventive measures for structures constructed in Earthquake prone area.	

Contribution to Outcome

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

1) Explain the concepts of Geology and its application for safe, stable and economic design of any civil engineering structure.
2) Interpret the lithological characters of the rock specimen and distinguish them on the basis of studied parameters.
3) Describe the structural elements of the rocks and implement the knowledge for collection and analysis of the geological data.
4) Interpret the geological conditions for the dam site and calculate RQD for the assessment of rock masses.
5) Analyze the given data and suggest rock mass rating for assessment of tunnelling conditions.
6) Interpret the causes of geological hazards and implement the knowledge for their prevention.

Internal Assessment (20 Marks):

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

End Semester Examination (80 Marks):

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

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

Recommended Books:

1) Text book of Engineering Geology: N. Chenna, Kesavulu, Mc-Millan.
2) Text book of Engineering and General Geology, 8th edition (2010): Parbin Singh, S K Kataria& Sons.
3) Text book of Engineering Geology: P. K. Mukerjee, Asia.
4) Text book of Engineering Geology: Dr. R. B. Gupte, Pune VidyarthiGriha
5) Prakashan, Pune.
6) Principles of Engineering Geology: K. M. Banger.

Reference Books:

7) A Principles of Physical Geology: Arthur Homes, Thomas Nelson Publications, London.
8) Structural Geology, 3rd edition (2010): Marland P. Billings, PHI Learning Pvt. Ltd. New Delhi
9) Earth Revealed, Physical Geology: David McGeeary and Charles C. Plummer
10) Principles of Geomorphology: William D. Thornbury, John Wiley Publications, New York.
11) Geology for Civil Engineering: A. C. McLean, C.D. Gribble, George Allen &UnwinLondon.
12) Engineering Geology: A Parthsarathy, V. Panchapakesan, R Nagarajan, Wiley India 2013.

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Semester - III

Course Code	Course Name	Credits
CEC304	Architectural Planning & Design of Buildings	02

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

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

Rationale

Drawing is the language of Civil Engineers to communicate. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field, on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Objectives

1) To remember and recall the intricate details of building design and drawing.
2) To gain an understanding of the basic concepts of building design and drawing.
3) To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices, rules, regulation and byelaws, Building codes
4) To identify, analyze, research literate and solve complex building design and drawing problems.
5) To have new solutions for complex building design and drawing problems.
6) To effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Course Outcomes

At the end of the course learners will be able to:

1) Remember and recall the intricate details of building design and drawing.
2) Understand the basic concepts of building design and drawing.
3) Learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
4) Identify, analyze, research literate and solve complex building design and drawing problems.
5) Have new solutions for complex building design and drawing problems.
6) Effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Detailed Syllabus		
Module	**Sub- Modules/ Contents**	**Periods**
1	**Principles and Codes of Practices for Planning and Designing of Buildings(Residential and Public buildings)**	**8**
1.1	Study of IS 962: 1989 – Code of Practice for Architectural and Building Drawings; How to develop Line plan into actual PLAN, ELEVATION, Section etc. including all the constructional details of various components in a BUILDING	
1.2	Principles of planning for Residential buildings	
1.3	Classification of buildings: Residential –Individual Bungalows & Apartments/Flats. Public – Education (Schools, Colleges etc.) &Health (Primary Health Center, Hospital) related buildings	
1.4	Study & drawing of SITE PLAN,FOUNDATION PLAN,ROOF PLAN of building; Study of building Bye – laws, Zoning Regulations and permissions required from commencement to completion of the building according to National Building Code (N.B.C.) of India and local Development Control (D.C.) rules	
1.5	Study of sun path diagram, wind rose diagram and sun shading devices	
1.6	Calculation of setback distances, carpet area, built-up area and floor spaceindex (FSI)	
1.7	Study of Principles of planning for public buildings: i) Building for education: schools, colleges, institutions etc. ii) Buildings for health: hospitals, primary health centers etc.	
2.	**Components and Services of a Building**	**3**
2.1	Staircase (dog -legged) planning, designing & drawing in details	
2.2	Foundations: stepped footing, isolated sloped footing and combined footing	
2.3	Openings: doors and windows	
2.4	Types of pitched roof and their suitability (plan and section)	
2.5	Building services: Water supply, sanitary and electrical layouts	
3.	**Perspective Drawings**	**4**
3.1	One-point perspective drawing	
3.2	Two-point perspective drawing	
4	**Town Planning, Architectural Planning & Built Environment**	**3**
4.1	Objectives and planning of TOWN PLANNING	
4.2	Master plan, Re-Development of buildings, Slum rehabilitation.	
4.3	Architectural Planning: introduction and principles	
4.4	Built Environment: introduction and principles	
5	**Green Buildings**	**2**
5.1	Introduction, uses ,objectives of Green Buildings and overview	
5.2	Study of Certification methods such as LEED, TERI, GRIHA, IGBC.	
6.	**Computer Aided Drawing (CAD)**	**6**
6.1	Details and learning methods of CAD in Civil Engineering structures	
6.2	Study and demonstration of any one of the professional CAD software’s	
	Total	**26**

Theory Examination:

1) Only 4 questions (out of 6) need to be attempted.
2) Question no. 1 will be compulsory and based on the drawing work of any one building, may be residential or public building.. Some questions from the remaining may be on Theory portion.
3) 4. Any 3 out of the remaining 5 questions need to be attempted.
4) In question paper, weightage of each module maybe approximately proportional to the number of lecture hours assigned to it in the syllabus.

Internal Assessment:

There will be **Two** class tests (to be referred to as an '**Internal Assessment'**) to be conducted in the semester. The first internal assessment (IA-I) will be conducted in the mid of the semester based on the 50% of the syllabus. It will be of 20 marks. Similarly, the second internal assessment (IA-II) will be conducted at the end of the semester and it will be based on next 50% of the syllabus. It will be of 20 marks. Lastly, the average of the marks scored by the students in both the Internal Assessment will be considered. Duration of both the IA examination will be of one hour duration, respectively. Civil Engineering Drawing (including Architectural aspect) by *M. Chakraborti* (Monojit Chakraborti Publications, Kolkata)

Recommended Books

1) Planning and Designing Buildings by Y. S. Sane (Modern Publication House, Pune)
2) Building Drawing and Detailing by B.T.S. Prabhu, K.V. Paul and C. V. Vijayan (SPADES Publication, Calicut)
3) Building Planning by Gurucharan Singh (Standard Publishers & Distributors, New Delhi)

References:

1) IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
2) National Building Code of India – 2005 (NBC 2005)
3) Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (https://mmrda.maharashtra.gov.in)
4) Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (https://www.nmmc.gov.in/development-control-regulations)
5) Development Plan and Control Regulation KDMC, https://mmrda.maharashtra.gov.in

Reference Codes:

1) National Building Code of India, 2005
2) IS 779-1978 Specification for Water Meter
3) IS 909-1975 Specification for Fire Hydrant
4) IS 1172-1983 Code of Basic Requirement for Water Supply, Drainage & Sanitation
5) IS 1742-1983 Code of Practice for Building Drainage

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Semester- III

Course Code	Course Name	Credits
CEC305	Fluid Mechanics - I	03

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

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

Rationale

The concept of fluid mechanics in civil engineering is essential to understand the processes and science offluids. The course deals with the basic concepts and principles in hydrostatics, hydro kinematics andhydrodynamics with their applications in fluid flow problems.

Objectives

The students will be able to learn:

1. The properties of fluids, units and dimensions
2. Pressure measurement, manometry, Hydrostatic forces acting on different surfaces, Principle of buoyancy and stability of floating body
3. Kinematic and Dynamic behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations.
4. Importance of fluid flow and various velocity measuring and discharge measuring devices used in pipes and channels.
5. The basic difference between incompressible and compressible flow, Propagation of pressure waves and stagnation points.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1		**Properties of Fluids**	05
		Mass density, weight density, specific gravity, specific volume, viscosity, compressibility and elasticity, surface tension, capillarity, vapour pressure, types of fluids, and introduction to real life applications.	
2		**Fluid Statics**	11
	2.1	**Pressure Measurement:** Pascal's law, hydrostatic law, pressure variation in fluids at rest. Pressure scale, Absolute, atmospheric, gauge pressure, measurement of pressure using manometers	
	2.2	**Hydrostatic force on surfaces:**	

		Total pressure and centre of pressure, total pressure on horizontal planesurface, vertical plane surface, Inclined plane surface, centre of pressure for vertical plane surface and for inclined plane surface, practical applications of total pressure and centre of pressure on dams, gates, and tanks.	
	2.3	**Buoyancy and floatation:** Archimedes principle, Meta-Centre, metacentric height, Stability of floating and submerged bodies, determination of metacentric height, Experimental and analytical methods, metacentric height for floating bodies containing liquid, Time period of Transverse oscillations of floating bodies.	
3	**Fluid Kinematics**		**05**
	Types of fluid flow, description of flow pattern, Lagrangian methods, Eulerian method, continuity equation, velocity and acceleration of fluid particles, streamline, streak line, path line,velocity potential and stream function, equipotential lines and flow net, uses of flow net, rotational and irrotational motions, circulation and vorticity		
4	**Fluid Dynamics**		**06**
	Control volume and control surface, Forces acting on fluid in motion, Navier Stokes Equation, Euler's Equation of motion, Integration of Euler's equations of motion, Bernoulli's Theorem and its derivation, Bernoulli's equation for compressible fluid and real fluid, practical applications of Bernoulli's Equation - Venturimeter, Orifice meter, nozzle meter, pitot tube, Rota meter.		
5	**Flow measurement**		**08**
	5.1	**Orifices and mouthpieces** Classification of orifices, flow through orifices, determination of hydraulic coefficients, flow through large rectangular orifice, flow through fully submerged and partially submerged orifice, time of emptying a tank through an orifice at its bottom. Classification of Mouthpieces, Flow through external cylindrical mouthpiece, convergent-divergent mouthpiece, Borda's mouthpieces.	
	5.2	**Notches and weirs** Classification of notches and weirs, discharge over a rectangular, triangular, trapezoidal notch/weir, velocity of approach, stepped notch, Cipolleti weir, broad crested weir, ogee weir, discharge over a submerged weir, ventilation of weirs.	
6	**6.1**	**Compressible flow**	**04**
		Basic equation of flow (elementary study), velocity of sound or pressure wave in a fluid, Mach number, propagation of pressure waves, area-velocity relationship, Stagnation properties.	
Total			**39**

Contribution to Outcome

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

1) Describe various properties of fluids and types of flow
2) Determine the pressure difference in pipe flows, application of Continuity equation and Bernoulli's theorem to determine velocity and discharge
3) Apply hydrostatic and dynamic solutions for fluid flow applications
4) Analyse the stability of floating bodies
5) Apply the working concepts of various devices to measure the flow through pipes and channels
6) Explain the compressible flow, propagation of pressure waves and stagnation properties

Internal Assessment (20 Marks):

Consisting Two Compulsory Class Tests:

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

End Semester Examination (80 Marks):

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

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

Recommended Books:

1) Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi
2) Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
3) Fluid Mechanics: Dr. A.K Jain, Khanna Publishers.
4) Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt.Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
5) Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
6) Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

Reference Books:

1) Fluid Mechanics: Frank M. White, Tata McGraw Hill International Edition.
2) Fluid Mechanics: Streeter White Bedford, Tata McGraw International Edition.
3) Fluid Mechanics with Engineering Applications: R.L. Daugherty, J.B. Franzini, E.J. Fennimore, Tata McGraw Hill, New Delhi.
4) Hydraulics: James F. Cruise, Vijay P. Singh and Mohsen M. Sherif, CENGAGE Learning India (Pvt.) Ltd.
5) Introduction to Fluid Mechanics: Edward J. Shaughnessy, Jr, Ira M. Katz, James P. Schaffer. Oxford Higher Education.

Semester- III

Course Code	Course Name	Credits
CEL301	Mechanics of Solids- LAB	01

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

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

Objectives

1) To learn stress - strain behavior and physical properties of materials and to compute the Stresses developed and deformation of Elastic members.
2) To compute the distribution of shear stress and the flexural (bending) stress across the cross section of structural members
3) To study circular shafts under the action of twisting moment.
4) To learn the computation of slope and deflection of elastic beams and general theorems used in this computation.

Outcomes

Learner will be able to…

1) Evaluate stress - strain behavior of materials and assess the structural behavior by the virtue of stresses developed and deformation of elastic members.
2) Analyze the material response under the action of shear and the effect of flexure (bending).
3) Predict the angle of twist and shear stress developed in torsion.
4) Evaluate slope and deflection of beams supported and loaded in different ways.

Term Work : Term work comprises of Laboratory work and assignments.

Laboratory work : (At least 6- Performances - Any one from each Module)

Mechanics of Solids (Practical performance)		
Schedule	**Name of Experiment**	**Duration (Hours)**
1st week	1) Using UTM find different Moduli of a material or 2) The Tension Test on M S rod or 3) The Tension Test on M S Flat	**2**
3rd week	1) The Compression Test on Concrete cube or 2) The Compression Test on Timber or 3) The Compression Test on Brick	**2**
5th week	1) Test of Bending Using a Strain Guage or 2) Test of Bending Using a other electronic devices or 3) Test of Shear Stress in Beams	**2**
7th week	1) Using TorsionTesting Machine, verify the torsion equation, find different Moduli of a material. or 2) Spring Stiffness Test using strain gauges or other electronic devices	**2**
9th week	1) Charpy impact testing and Energy concept. or 2) Izod impact testing and Energy concept.	**2**
11th week	1) Using U T M perform experiments and verify Slope and deflection equations, 3 points and 4 points loading. (Performance) or 2) Deflection of Simply supported Beams (Performance) or 3) Deflection of Cantilever Beams (Performance)	**2**
Total Duration = 12 Hours		

Assignment:

(At least 1 from each module as per the Course instructor's guidelines; it is to be assessed during Laboratory hours. In order to avoid Copying/ repetition, Course Instructor may give different assignments to different groups.)

Mechanics of Solids		
Schedule	**Assignment**	**Duration (Hours)**
2nd week	**Stresses and strains in Elastic members, Spherical and Cylindrical shells** • Prepare a model of Cylindrical vessel or • Prepare a model of spherical vessel or • Prepare a model of Cylindrical vessel with hemispherical ends or • Prepare a chart showing diagrammatic representation of stresses or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • Write a Computer program in C++ or MSExcel on how to find a particular quantity from given data (Ex: Find output, Elongation 'б' from the input values of P,L,A and E) • A chart about scientists and their contribution to the study of 'Mechanics of Solids' (Example given at the end of this document – Appendix I)	**2**

4th week	**Axial force, shear force and bending moment diagrams for beams and portal frames** • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of 'Mechanics of Structures' (Example given at the end of this document) or • Prepare a chart showing AFD, SFD & BMD for different symmetric and asymmetric loads on S S beams or • Prepare a chart showing AFD, SFD & BMD for different loads on Cantilever beams	**2**
6th week	**Area Moment of Inertia, Bending stresses and Shear stresses in beams** • Prepare a chart showing MI @ XX, YY &ZZ axes passing through the centroid. or • Prepare 3D models of different typical cross sections of beams and find their cross sectional area, Ixx, Iyy and Izz.. or • Prepare charts showing typical cross sections and variation of Bending stresses and shear stresses across the cross section. or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • Write a Computer program in C++ or MS Excel on how to find a particular quantity from given data (Ex: Find output, Flexural stress 'f' from the input values of P,L,I and E) • A chart about scientists and their contribution to the study of 'Mechanics of Structures' (Example given at the end of this document)	**2**
8th week	**Torsion of Shafts, Columns** • Prepare 3D models of different solid and hollow circular cross sections of shafts and find their cross sectional area, Ixx, Iyy and Izz. or • A set of 5 questions on a module designed by course instructor, or • Write a Computer program in C++ or MS Excel on how to find a particular quantity from given data (Ex: Find output, Shear stress 'q' or angle 'Θ' from the input values of T,L,G and J) • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of 'Mechanics of Solids' (Example given at the end of this document)	**2**
10th week	**Principal planes and stresses, Strain Energy** • Draw typical stress transformation cases of Mohr's circle using graph paper. or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of 'Mechanics of solids' (Example given at the end of this document)	**2**

12th week	**Slope and Deflection in Beams ; General Theorems** • Prepare chart to explain General theorems for slope and deflection. or • A set of 5 questions on a module designed by course instructor, or • A site visit to a relevant place or • A model / chart based on a module or • Design of a new experiment based on a module or • A chart about scientists and their contribution to the study of 'Mechanics of Solids' (Example given at the end of this document)	**2**
Total Duration = 12 Hours		

Appendix -I:

A chart about scientists and their contribution to the study of 'Mechanics of solids' be made by students. Contributions of Scientists like GiordanoRiccati, Leonhard Euler, Saint Venant, Christian Otto Mohr, William J M Rankine, Carlo Castigliano, EnricoBetti, Robert Hooke, W. H. Macaulay, Augustin- Louis Cauchy, Simeon Poisson can be studied and presented.

Important Websites:

1) http://www.iitk.ac.in/mseold/mse_new/facilities/laboratories/Material Testing Lab / MSE313A.pdf
2) https://home.iitm.ac.in/kramesh/Strength of Materials Laboratory Manual.pdf
3) https://www.researchgate.net/publication/338139499_Me_8381-Strength_Of_Materials_Lab_Manual

Assessment:

To be done in 13th week

- **Term Work:**

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

Laboratory work- : 15 Marks
Assignments- : 10 Marks
The sum will be multiplied by a factor of attendance between
0.5 (for poor attendance) to 1 (very good attendance).

- **End Semester Oral Examination**

Oral examination will be based on entire syllabus

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Semester- III		
Course Code	**Course Name**	**Credits**
CEL302	**Engineering Geology Lab. Practice**	**1**

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

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	3 hrs	25	-	25	50

Objectives

1. To acquire basic knowledge of Geological Lab practices and apply it for the safe development of Civil Engineering works.
2. To examine the mineral and rock sample and understand their fundamental properties for their evaluation as construction and foundation material.
3. To study the Geological maps and their sections in terms of selecting the sites for various civil engineering structures.
4. To study Borehole problems for determination of subsurface geology of the area.
5. To Study the drilling data and calculate RQD for assessment of rock masses for Civil Engineering purposes.

Outcomes

Learner will be able to…

1. Identify various rock forming minerals on the basis of physical properties.
2. Explain the characteristics of Igneous, Sedimentary and Metamorphic rocks and assess their suitability as construction material and foundation rock.
3. Interpret the rock characteristics and comment on their suitability as water bearing horizons.
4. Interpret the geological map and assess the suitability of the site for Civil Engineering works.
5. Solve the borehole problems and interpret it in order to understand subsurface Geology of the area.
6. Calculate RQD and evaluate the rock masses for Civil Engineering Works.

A) List of Experiments

Module	Detailed Contents	Lab Sessions/Hr
1	**Study of Physical Properties of Minerals:** Identification of common Rock forming minerals on the basis of physical Properties- **Silica Group:** Quartz and its varieties; Cryptocrystalline silica: Jasper and Agate; **Feldspar Group:** Orthoclase, Plagioclase; **Carbonate Group:** calcite; **Amphibole Group:** Asbestos, Actinolite and Hornblende; **Pyroxene Group:**Augite; **Mica Group:**Muscovite, Biotite and Talc; **Element Group:** Graphite.	6
2	Identification of Metallic minerals: Galena, Pyrite, Hematite, Magnetite.	2
3	**Identification of rocks:** **Igneous Rocks**-Granite and its varieties, Syenite, Diorite, Gabbro, Pegmatite. Porphyry, Dolerite, Rhyolite, Pumice, Trachyte, Basalt and its varieties, Volcanic Breccia, Volcanic Tuffs.	4
4	**Sedimentary Rocks-** Conglomerate, Breccia, Sandstone and its varieties, Shales, Limestones, Laterites.	2
5	**Metamorphic Rocks-** Schist and its varieties, Gneiss and its varieties, Slate, Marbles, Quartzite and Phyllite.	2
6	**Geological Maps:** a) Horizontal strata: Drawing the cross section and assessment of geological history of the area. b) Inclined Strata: Calculation of dip and strike in an inclined strata and assessment of geological history of the area. c) Assessment of the geological conditions for a proposed dam site in the given map. d) Assessment of the geological conditions for a proposed tunnel site in the given map. e) Assessment of the geological conditions for groundwater reserve in the given map.	6
7	Borehole problems to interpret subsurface geology	2
8	Calculation of RQD from the given data and assessment of rock quality.	2

B) Assessment:

- **Term Work**

Including Laboratory Work and Assignments both, Distribution of marks for Term Work Shall beas follows:

Laboratory work- : 10 Marks
Assignments- : 10 Marks
Attendance : 05 Marks

- **End Semester Oral Examination**

Oral examination will be based on the entire syllabus.

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Semester- III

Course Code	Course Name	Credits
CEL 303	Architectural Planning & Design of Buildings Lab	01

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

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

@ **For the course 'Building Design and Drawing, the oral examination shall be conducted in conjunction with the sketching examination.**

Rationale

Drawing is the language of Civil Engineers to communicate. Drawing is one of the most essential documents as far as civil engineering is concerned. It provides guidance and instructions to architects, engineers and workmen at field, on how to construct structures according to the figures and dimensions shown in the drawing. Approved drawings are also essential for the estimation of cost and materials; as well as a very important contract document.

Course Objectives

1) To remember and recall the intricate details of building design and drawing.
2) To gain an understanding of the basic concepts of building design and drawing.
3) To learn how to apply professional ethics and act responsibly pertaining to the norms of building design and drawing practices.
4) To identify, analyze, research literate and solve complex building design and drawing problems.
5) To have new solutions for complex building design and drawing problems.
6) To effectively communicate ideas, related to building design and drawing, both orally as well as in written format like reports & drawings.

Course Outcomes:

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

1) Plan and design of residential and public building by implementing the principles of planning of buildings, Green building principles, byelaws, regulations and codes for planning

2) Preparing various working and detailed drawing of the buildings in CAD.
3) Preparing layouts of various building services.
4) Preparing perspective views for all types of buildings
5) Preparing the reports based on the drawings prepared, if required

Practical:

Students should make all the drawings during the Practical time allotted to them.

1) Drawings (Manually) should be drawn in the allotted Drawing hall only.
2) Drawings (CAD sheets) should be drawn on the Desktop/Laptop in Computational Lab.

After completing the work, Print out of those sheets should be submitted for gradation/Marks.

Assignments:

Two Assignments should be completed, covering all the modules in the syllabus.

1) Assignment-1 should be on 50% of the syllabus, to be completed before Internal Assessment-I exam.
2) Assignment-2 should be on the remaining 50% of the Syllabus, to be completed before Internal Assessment-II exam.

Site Visit:

Students should visit any Residential building/Public building physically and take Measurements inside of all rooms & over all outside of the building & can submit asmalldrawing sheet with the help of CAD. (**Optional** only)

Practical Examination (Oraland Sketching)

Practical examination will consist of sketching and oral examination based on the entire syllabus.

Term Work:

Drawings & Assignments:

1) Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, Site plan, Foundation Plan and details of one FOOTING, Roof Plan ,schedule of opening and construction notes of a **residential building(bungalow or apartment)** to be constructed as a (G+1) R.C.C. framed structure **(only Manual Drawing)**
2) **One-Point** Perspective drawingfor any Residential structure(**only Manual drawing)**
3) Ground floor plan, first floor plan, elevation, section passing through at least one sanitary unit & staircase, schedule of opening and construction notes of a **public building(**Education/Health related **)** be constructed as a (G+1) R.C.C. framed structure (**only CAD drawing Sheet**)
4) **Two-Point** perspective drawing for any one public building (**only CAD drawing Sheet**)
5) Assignment No.- 1
6) Assignment No.- 2

Distribution of Term-work Marks:

The marks of term-work shall be judiciously awarded depending upon the quality of the term work. The final certification acceptance of term-work warrants the satisfactorily the appropriate completion of the required quality & quantity of work for the minimum passing marks to be obtained by the students. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

	Particulars	**Marks**
1	Drawing Sheet (Manual)	**7.5** Marks
2	Drawing Sheet (CAD Based)	**7.5** Marks
3	Assignments	**5** Marks
4	Attendance	**5** Marks
	Total	**25 Marks**

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

Recommended Books:

- Building Drawing with an Integrated Approach to Built Environment by *M. G. Shah, C. M. Kale, S.Y. Patki*(Tata McGraw-Hill Education)
- Civil Engineering Drawing (including Architectural aspect) by *M. Chakraborti* (MonojitChakraborti Publications, Kolkata)
- Planning and Designing Buildings by *Y. S. Sane* (Modern Publication House, Pune)
- Building Drawing and Detailing by *B.T.S. Prabhu, K.V. Paul and C. V. Vijayan* (SPADES Publication, Calicut)
- Building Planning by *Gurucharan Singh* (Standard Publishers & Distributors, New Delhi)

References:

- IS 962: 1989 – Code of Practice for Architectural and Building Drawings.
- National Building Code of India – 2005 (NBC 2005)
- Development Control Regulations for Mumbai Metropolitan Region for 2016 – 2036 (https://mmrda.maharashtra.gov.in)
- Development Control Regulations for Navi Mumbai Municipal Corporation – 1994 (https://www.nmmc.gov.in/development-control-regulations)
- Development Plan and Control Regulation KDMC, https://mmrda.maharashtra.gov.in

Reference Codes:

- National Building Code of India, 2005
- IS 779-1978Specification for water meter
- IS 909-1975 Specification for fire hydrant
- IS 1172-1983 Code of basic requirement for water supply ,drainage & sanitation
- IS 1742-1983 code of practice for building drainage

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Semester- III

Course Code	Course Name	Credits
CEL304	Fluid Mechanics – I (Lab)	01

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

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

Course Objectives:

The students will be able to learn:

1. The basic fluid mechanics concepts
2. Measuring pressure, velocity and discharge of fluid flow through pipes and channels

Course Outcomes:

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

1. Calculate the metacentric height
2. Verify the Bernoulli's theorem
3. Determine the discharge coefficients
4. Measure fluid flow using various devices
5. Determine the hydraulic coefficients of an orifice

List of Experiments (Minimum Six)

Module	Detailed Contents	Lab Sessions/Hr
1	Determination of the Metacentric height of a floating body	02 hrs
2	Investigating the validity of the Bernoulli equation applied to a steady flow of water through a tapered duct	04 hrs
3	Determination of coefficient of discharge of Venturimeter.	02 hrs
4	Determination of coefficient of discharge of Orifice meter.	02 hrs
5	Determination of coefficient of discharge of Nozzle meter.	04 hrs
6	Determination of coefficient of discharge of Notches (Rectangular and Triangular notch).	02 hrs
7	Determination of coefficient of discharge of weirs (Broad Crested weir and Ogee weir).	04 hrs
8	To determine the value of coefficient of contraction, coefficient of velocity and coefficient of discharge for the given orifice	04 hrs
9	Determination of coefficient of discharge of mouthpiece.	02 hrs

Assessment:

Term Work

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

Laboratory work	:	15 Marks
Assignments	:	05 Marks
Attendance	:	05 Marks

End Semester Oral Examination

Oral examination will be based on entire syllabus.

Reference Books:

- Fluid Mechanics and Hydraulic Machines: R. K. Rajput, S. Chand and Company
- Hydraulics and Fluid mechanics: Dr.P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi
- Hydraulics Fluid Mechanics and Fluid Machines: S. Ramamrutham, DhanpatRai Publishing Company (P) Ltd-New Delhi
- Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
- Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
- Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
- Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

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Semester-III

Course Code	Course Name	Credits
CEL305	Skill Based Lab Course-I Computer Aided Drafting & Building Information Modelling	1.5

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	3	-	-	1.5	-	1.5

Theory					Term Work /Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	50	-	-	50

Objectives:

1. To enable the learners efficiently draft and label buildings components using the concepts of 2D and 3D drawing and detailing
2. To introduce the concepts of object-based modelling in 3-D environment to learners
3. To enable the learners to work on drawing and drafting softwares so that they can conveniently understand and design civil engineering components through the softwares.

Outcomes: Learner will be able to…

1. Transfer the plan from a drawing sheet to a 2-D drafting software
2. Visualize the various elements in the software like points, lines, polygons, etc. as objects of the real world and relate it with civil engineering components.
3. Apply civil engineering concepts to draft efficient civil engineering plans in accordance to various building bye laws and forms.
4. Conceptualize the space, logistic and statutory constraints in the real world to draw an efficient plan so that optimization is achieved
5. Attach and retrieve information pertaining to various civil engineering components through 3-D modelling software
6. Demonstrate a virtual walkthrough of buildings

C) **List of Experiments (Minimum Eight)**

Module	Detailed Contents	Lab Sessions/Hr
1	Listing out the various Computer Aided Drawing and Drafting (CADD) tools available for civil engineering projects in the market and highlighting the capabilities and advantages of each	03
2	Basic introduction to compatibilities, utilities and attributes of peculiar drafting softwares w.r.t their various commands, features, capabilities and functions.	03
3	Line plan of a residential structure using a CADD tool	03

4	Developed plan of a residential structure (minimum G+4) using a CADD tool	06
5	Developed plan of a public building using a CADD tool	06
6	Basic introduction to compatibilities, utilities and attributes of peculiar building information modelling (BIM) softwares w.r.t their various commands, features, capabilities and functions.	03
7	Creating families and basic models on BIM	06
8	Creating architectural plan on BIM of a G+1 bungalow	03
9	Demonstrating a walkthrough on BIM for clients and presenting it	03
10	Clash detection and removal	03

D) Assessment:

- **Term Work**

Including Laboratory Work comprising of minimum 6 software generated sheets and one walkthrough presentation on BIM, distribution of marks for Term Work shall be as follows:

Laboratory work : 30 Marks (comprising of minimum 6 software generated sheets)

Presentation : 10 Marks (showing 3-D walk through the building)

Attendance : 10 Marks

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Semester- III

Course Code	Course Name	Credits
CEM 301	Mini Project -1 A	1.5

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

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

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
- Marks awarded by guide/supervisor based on log book : 10
- Marks awarded by review committee : 10
- Quality of Project report : 05

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

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
- First shall be for finalisation of problem
- Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
- First review is based on readiness of building working prototype to be conducted.
- Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1) Quality of survey/ need identification
2) Clarity of Problem definition based on need.
3) Innovativeness in solutions
4) Feasibility of proposed problem solutions and selection of best solution
5) Cost effectiveness
6) Societal impact
7) Innovativeness
8) Cost effectiveness and Societal impact
9) Full functioning of working model as per stated requirements
10) Effective use of skill sets
11) Effective use of standard engineering norms
12) Contribution of an individual's as member or leader
13) Clarity in written and oral communication

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

Guidelines for Assessment of Mini Project Practical/Oral Examination:

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

Mini Project shall be assessed based on following points;

1) Quality of problem and Clarity
2) Innovativeness in solutions
3) Cost effectiveness and Societal impact
4) Full functioning of working model as per stated requirements
5) Effective use of skill sets
6) Effective use of standard engineering norms
7) Contribution of an individual's as member or leader
8) Clarity in written and oral communication

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Second Year Civil Engineering
UNIVERSITY OF MUMBAI
(With Effect from **2020-2021**)

Semester – IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC401	Engineering Mathematics - IV	3	--	1	3	-	1	4
CEC402	Structural Analysis	4	--	-	4	-	-	4
CEC403	Surveying	3	--	-	3	-	-	3
CEC404	Building Materials & Concrete Technology	3	--	-	3	-	-	3
CEC405	Fluid Mechanics-II	3	-	-	3	-	-	3
CEL 401	Structural Analysis	--	2	-	-	1	-	1
CEL 402	Surveying	--	3	-	-	1.5	-	1.5
CEL 403	Building Material Concrete Technology	--	2	-	-	1	-	1
CEL 404	Fluid Mechanics-II	--	2			1		1
CEL 405	Skill Based lab Course	--	2	-	-	1	-	1
CEM401	Mini Project – 1 B	--	$3^{\$}$	-	-	1.5	-	1.5
Total		**16**	**14**	**1**	**16**	**7**	**1**	**24**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)-	Term Work	Prac. /Oral	Total
		Test I	Test II	Avg.					
CEC 401	Engineering Mathematics - IV	20	20	20	80	3	25	-	125
CEC 402	Structural Analysis	20	20	20	80	3	-	-	100
CEC 403	Surveying	20	20	20	80	3	-	-	100
CEC 404	Building Materials & Concrete Technology	20	20	20	80	3	-	-	100
CEC 405	Fluid Mechanics-II	20	20	20	80	3	-	-	100
CEL 401	Structural Analysis						25	25	50
CEL 402	Surveying						50	25	75
CEL 403	Building Materials & Concrete Technology	-	-	-	-	-	25	25	50
CEL 404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL 405	Skill Based lab Course	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1 B	-	-	-	-	-	25	25	50
	Total			**100**	**400**	**-**	**225**	**125**	**850**

Semester- IV

Course Code	Course Name	Credits
CEC 401	Engineering Mathematics-IV	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	01	03	-	01	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	25	-	-	125

Pre-requisite:

- Engineering Mathematics-I,
- Engineering Mathematics-II,
- Engineering Mathematics-III,

Objectives:

1) To study the concept of Vector calculus & its applications in engineering.
2) To study Line and Contour integrals and expansion of complex valued function in a power series.
3) To familiarize with the concepts of statistics for data analysis.
4) To acquaint with the concepts of probability, random variables with their distributions and expectations.
5) To familiarize with the concepts of probability distributions and sampling theory with its applications.

Outcomes: Learner will be able to….

1) Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's theorem & Gauss Divergence theorem.
2) Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3) Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.
4) Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
5) Apply the concept of probability distribution to engineering problems& Testing hypothesis of small samples using sampling theory
6) Apply the concepts of parametric and nonparametric tests for analysing practical problems.

Module	Detailed Contents	Hrs.
01	**Module : Vector Calculus** 1.1 Solenoidal and irrotational (conservative) vector fields. 1.2 Line integrals – definition and problems. 1.3 Green's theorem (without proof) in a plane, Stokes' theorem (without Proof), Gauss' Divergence theorem (without proof) and problems (only evaluation). **Self Learning Topics**: Identities connecting Gradient, Divergence and Curl, Angle between surfaces. Verifications of Green's theorem, Stoke's theorem & Gauss-Divergence theorem, related identities & deductions.	**07**
02	**Module: Complex Integration** 2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 2.2 Taylor's and Laurent's series (without proof). 2.3 Definition of Singularity, Zeroes, poles of $f(z)$, Residues, Cauchy's Residue Theorem (without proof) **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	**07**
03	**Module: Statistical Techniques** 3.1 Karl Pearson's Coefficient of correlation (r) and related concepts with problems 3.2 Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems) 3.3 Lines of regression 3.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	**06**
04	**Module: Probability Theory:** 4.1 Conditional probability, Total Probability and Baye's Theorem. 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, 4.3 Expectation, Variance, Co-variance, moments, Moment generating functions, (Four moments about the origin &about the mean). **Self- learning Topics:** Properties variance and covariance,	**06**
05	**Module: Probability Distribution and Sampling Theory-I** 5.1 Probability Distribution: Poisson and Normal distribution 5.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 5.3 Students' t-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t- test) **Self -learning Topics:** Test of significance of large samples, Proportion test, Survey based project.	**07**
06	**Module: Sampling theory-II** 6.1 Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate's Correction. 6.2 Analysis of variance: F-test (significant difference between variances of two samples) **Self- learning Topics:** ANOVA**:** One way classification, Two-way classification (short-cut method).	**06**

Term Work:

General Instructions:

1) Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practical.
2) Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3) A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

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

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

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Vector Analysis, Murray R. Spiegel, Schaum Series
5. Complex Variables and Applications, Brown and Churchill, McGraw-Hilleducation
6. Probability Statistics and Random Processes, T. Veerarajan, Mc. GrawHilleducation.

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Semester-IV		
Course Code	**Course Name**	**Credits**
CEC402	**Structural Analysis**	**4**

Contact Hours			Credits Assigned			
Theory	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
4	**-**	**-**	**4**	**-**	**-**	**4**

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

Rationale

Different components of civil engineering structures are subjected to variousforce systems and their combinations. For designing the components, these are analyzed for their response. The structural systems are determinate or indeterminate in nature and so there are different analysis methods.These will be learnt in this course. Subject knowledge of Engineering Mechanics and Mechanics of solids is the prerequisite of this course.

Their application on solids and mechanisms, the action of force systems is studied and further extended in this subject. Learner will learn to apply these to the analysis of various members of structural systems such as beams, trusses, portal frames and arches. These analyses will further be used while designing of Steel and RCC structures.

Objectives

1. To analyze for axial force in the Coplanar, perfect trusses and analysis of 3- Hinged arches.
2. To study the concept of Influence Line Diagrams for Reactions, SF and B M in beams and axial forces in trusses and their application for rolling load systems.
3. To learn methods for evaluating rotation and displacement parameters in respect of frames andtrusses using various methods. To understand static and kinematic indeterminacy of structures.
4. To analyze the indeterminate structures using Flexibility methods and Using Clapeyron's Theorem..
5. To analyze the indeterminate structures such as beams & simple rigid jointed framesusing direct stiffness method.
6. To analyze the indeterminate structures using Moment Distribution as Stiffness method and Plastic analysis of structures.

Detailed Syllabus			
Module		**Course Modules / Contents**	Duration
1		**Trusses and 3 hinged Arches**	**(9)**
	1.1	**Trusses**: Analysis of Perfect Coplanar Trusses by Method of Joints (3) Analysis of Perfect Coplanar Trusses by Method of sections.(3)	**6**
	1.2	**Three hinged elastic arches,** Determination of normal thrust, radial shear and bending moment for Symmetrical & Unsymmetrical parabolic three hinged arches.(3)	**3**
2		**Influence line diagrams and rolling loads**	**(09)**
	2.1	Influence lines for Reactions, shear force and bending moment at a section of cantilever, simply supported, overhanging beams without internal hinges. (2) Rolling loads, Determination of S F and BM at a section, Value and criteria for maximum shear force and bending moment, absolute maximum shear force and bending moment under rolling loads (UDL and series of point loads) for simply supported girder. (4)	**6**
	2.2	I L D for Axial forces in members of Pin jointed trusses (3)	**3**
3		**Determinate and Indeterminate structures**	**(8)**
	3.1	Deflection of Statically determinate structures, methods based on energy principles and Castigliano's theorems to evaluate deflection in portal frames, bent up and arch type structures. Application of Unit Load Method for calculating slope and deflection of a point on rigid jointed frames and deflection of a point on Pin jointed truss.	**5**
	3.2	Static and kinematic indeterminacies: Types of structures occurring in practice, their classification, linear and non-linear behavior of materials, geometric non-linearity, static and kinematic determinacy and indeterminacy of structure.	**3**
4		**Analysis of indeterminate structures by Flexibility method**	**(9)**
	4.1	Analysis of fixed beam. Application of Clapeyron's theorem of three moments to fixed beam and continuous beam.	**4**
	4.2	Flexibility coefficients and their use in formulation of compatibility equations. Application of flexibility method to propped cantilevers, fixed beams & continuous beams, Simple rigid jointed frames.	**5**
5		**Analysis of indeterminate structures by Stiffness method**	**(8)**
	5.1	**Direct stiffness method:** Stiffness coefficients for prismatic members and their use for formulation of equilibrium equations.	**4**
	5.2	Application of Direct stiffness method to indeterminate beams & simple rigid jointed frames.	**4**
6		**Moment distribution method and Plastic Analysis of structures.**	**(9)**

	6.1	**Moment distribution method:** Application to indeterminate beams & simple rigid jointed frames & frame with inclined member but having only single translation degree of freedom including the effect of support settlement.	**5**
	6.2	**Plastic analysis of structures**: Introduction to plastic analysis, concept of plastic hinge, plastic moment carrying capacity, shape factor. Static and kinematic method of plastic analysis.Determination of collapse load for single and multiple span beams.	**4**

Contribution to Outcome

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

1. Calculate axial forces in the Coplanartrusses by using Method of joints and method of sections and also calculate radial shear, normal thrust and bending moment in parabolic 3-Hinged arches.
2. Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them..
3. Evaluate rotation and displacement at a joint of frames and deflection at any joint of truss and will be able to compute static and kinematic indeterminacy of structure.
4. Apply Flexibility methods and make use of Clapeyron's Theorem to analyze the indeterminate structures.
5. Analyse the indeterminate structures such as beams & simple rigid jointed frames using direct stiffness method.
6. Analyse the indeterminate structures using Moment Distribution as Stiffness method and make plastic analysis.

Internal Assessment (20 Marks):
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Recommended Books:

1. Basic Structural Analysis: *C.S. Reddy*, Tata McGraw Hill New Delhi.
2. Mechanics of Structures: Vol-I: S. B. Junnarkar and H.J. Shah, Charotar Publishers, Anand.
3. Analysis of Structures: Vol. I and II, Vazirani and Ratwani

4. Strength of Materials: S. Ramamrutham, Dhanpatrai and Publishers, Delhi
5. Theory of Structures: S. Ramamrutham, Dhanpatrai and Sons, Delhi
6. Structural Analysis I: HemantPatil, YogeshPatil, Jignesh Patel, Synergy Knowledgeware, Mumbai.
7. Strength of Materials: Rajput, S. Chand Publications, Delhi
8. Structural Analysis: Bhavikatti, Vikas publisher house Pvt, ltd.
9. Structural Analysis: DevdasMenon, Narosa Publishing House.
10. Basic Structural Analysis: K.U. Muthu, Azmi Ibrahim, M. Vijyanand,
11. MagantiJanadharnand. I.K.International Publishing House Pvt. Ltd.
12. Comprehensive Structural Analysis: Vol-I and II by Vaidyanathan R. and Perumal R.LaxmiPublications.
13. Elementary Structural Analysis: Jindal
14. Structural Analysis: L.S. Negi and R.S. Jangid, Tata Mc-Graw Hill India
15. Fundamentals of Structural Analysis: Sujit Kumar Roy and SubrotaChakrabarty, S. Chand Publications.
16. Structural Analysis: T.S. Thandavamoorthy, Oxford University Press.
17. Structural Analysis: Manmohan Das, Bharghab Mohan Pentice Hall International. .

Reference Books:

1. Structural Analysis: *Hibbler*, Pentice Hall International.
2. Structural Analysis: *Chajes*, ElBS London.
3. Theory of Structures: *Timoshenko and Young*, Tata McGraw Hill New Delhi.
4. Structural Analysis: *Kassimali*, TWS Publications.
5. Element of Structural Analysis: *Norris and Wilbur*, McGraw Hill.
6. Structural Analysis: *Laursen H.I*, McGraw Hill Publishing Co.
7. Structural theorem and their application: *B.G. Neal*, Pergaman Press.
8. Fundamentals of Structural Analysis: *K.M. Leet*, C.M. Uang and A.M. Gilbert, Tata McGraw Hill, New Delhi.
9. Elementary theory of Structures: *Hseih*, Prentice Hall

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Semester- IV

Course Code	Course Name	Credits
CEC403	Surveying	03

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

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

Rationale

As it is always said "well begun is half done". All civil engineering projects such as buildings, roads, bridges, railways, airports, dams, water treatment plants, sewage treatment plants begin with surveying. Knowledge of surveying is thus fundamental and very useful to all civil engineers. In this course, the students are well informed about the principles and methods of surveying. The students are made conversant with various instruments which are used in the field to take measurements for preparation of drawings. The course introduces the advancements in instruments and methods of surveying. The study deals with the methods of computing land areas and volume of earthworks. The course also covers horizontal and vertical curves.

Objectives

The students will be able to learn:

1. The basic principles and classification of surveying.
2. Various methods of measurements in surveying.
3. The appropriate techniques of surveying and skills of collecting field data for preparing drawings.
4. Advancements in instruments and methods of surveying.
5. The methods of computing areas and volumes using the site specific data for various purposes.
6. The setting out techniques of curves.

Detailed Syllabus

Module	Course Modules/ Contents		Periods
1	**Introduction**		**5**
	1.1	Definition, principles, objectives, fundamental classification-plane and geodetic.	
	1.2	Chaining, Ranging and offsetting: Definitions, Principles, Instruments required, Obstacles, conventional signs and symbols.	
	1.3	Bearings – Different types, compass – prismatic, surveyor, dip,declination and local attraction, compass traversing	
2	**Levelling and Contouring**		**8**
	2.1	Definitions, basic terms, types of instruments-dumpy level and Auto level, principal axes of dumpy level, temporary and permanent adjustments	
	2.2	Booking and reduction of levels, plane of collimation (HI) and rise-fall methods, computation of missing data, distance to the visible horizon,corrections due to curvature and refraction, reciprocal levelling, Numerical problems	
	2.3	Differential levelling, profile levelling, fly levelling, check levelling, precise levelling, sources of errors,difficulties in levelling work, corrections and precautions work in levelling	
	2.4	Contouring: terms, contour, contouring, contour interval, horizontal equivalent Direct and indirect methods of contouring, interpolation of contours, uses of Contours and characteristics of contour lines. Grade contour	
3	**Theodolite Surveying**		**8**
	3.1	Various parts and axes of transit, technical terms, temporary and permanent adjustments of a transit, measurement of horizontal and vertical angles, Methods of repetition and reiteration.	
	3.2	Different methods of running a theodolite traverse, Latitudes and departures,rectangular coordinates,traverse adjustments by Bowditch's, transit and Modified transit rules, Gales Traverse Table, Numerical Problems.	
	3.3	Miscellaneous use of theodolite for various works such as prolongation of a straight line,setting out an angle, bearing measurements.Omitted measurements, Problems in using theodolite traversing, errors in theodolite traversing.	
4	**Indirect and Advanced Methods of Measurement**		**7**
	4.1	Tacheometry-Principle, Objective, Suitability and different methods of tacheometry, Stadia formula, Radial contouring , numerical on stadia method only	
	4.2	Electronic Distance Measurement: Working Principles, types, applications in surveying	
		Total Station- Working Principles, applications in surveying	
	4.3	Introduction to GPS	
	Plane Table Surveying, Areas and Volumes		**5**

5	5.1	Definition, principle, accessories required for plane table surveying, merits and demerits, temporary adjustments, Different methods of plane table surveying	
	5.2	Areas: Area of an irregular figure by trapezoidal rule, average ordinate rule,Simpson's 1/3 rule, various coordinate methods.Planimeter: types including digital planimeter, area of zero circle, uses of planimeter.	
	5.3	Volumes: Computation of volume by trapezoidal and prismoidal formula,volume from spot levels, volume from contour plans.	
6	**Curves**		**6**
	6.1	Horizontal Curves-Definitions of different terms, necessity and types of curves.Methods of setting out Simple circular curves- linear methods and Angular methods (Numericals on simple circular curves only)	
	6.2	Vertical curves– Definitions, geometry and types. Tangent correction and chord gradient methods.	
		Total	**39**

Contribution to Outcomes

After completion of the course, the learner will be able to:

1. 1.Apply the principles of surveying and field procedures to conduct the various surveys
2. Use various methods for taking linear and angular measurements
3. Collect, record and analyse the field data for preparing drawings.
4. Explain the advancements in instruments and methods
5. 5.Calculate the area of land and volume of earthwork
6. Set out curves

Internal Assessment (20 marks):
Consisting **Two Compulsory Class Tests:**
First test based on approximately 40% of the contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 marks):

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

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

Recommended Books:

1. Surveying and Levelling: R. Agor, Vol. -I, 11th Edition, Khanna Publishers (ISBN8174092358)

2. Surveying and Levelling:Kanetkar and Kulkarni, Vol. -I, 24^{th} Edition, Pune Vidyarthi Griha, Pune. (ISBN 8185825114)
3. Surveying and Levelling:Dr. B.C. Punmia, Vol.-I, 16^{th} Edition, Vol. -II 4^{th} Edition, Laxmi Publications (ISBN9788170088530)
4. Surveying and Levelling: N NBasak, 2^{nd} Edition, Tata McGraw Hill, New Delhi. (ISBN 9789332901537)

Reference Books:

1. Surveying: Volume -I: Dr K.R. Arora, Standard Book House.
2. Surveying and Levelling (2nd Edition): R. Subramanian; Oxford Higher Education.
3. Surveying and Levelling (Vol.-I): S.K. Duggal, Tata McGraw Hill
4. Textbook of Surveying, C Venkatramaiah, University Press, Hyderabad, Latest Edition
5. Fundamentals of Surveying, S.K. Roy, Prentice Hall India, New Delhi
6. Surveying for Engineers, John Uraine and Bill Price, Palgrave Macmillan
7. Surveying: Theory and Practice, James Anderson, Edward M. Mikhail, Tata Mcgraw Hill

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Semester - IV

Course Code	Course Name	Credits
CEC 404	Building Materials & Concrete Technology	03

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

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

Rationale

Materials are essential elements, constituent parts (or) substances which are used to raise a building, but materials could not be turned into structures without a method of construction. This course provides necessary knowledge about properties, uses of different types of building materials and the selection of materials, its mix proportioning, mixing, placing, compacting and curing. This course is intended for gaining useful knowledge with respect to facts, concepts, principles and procedures related to building materials and concrete technology so that student can effectively execute quality control during building construction work.

Objectives

1. To identify the good and significant materials to be used for the construction work and their associated quality, durability, warrantees, and availability.
2. To study the manufacturing process, properties and use of different types of building materials like stone, brick, glass, timber and the materials such as paints and varnishes used for the treatment of surfaces so as to achieve good knowledge about the building materials.
3. To acquire a thorough knowledge about the properties and significance of different materials used for the manufacturing of concrete.
4. To study the properties, test conducted and significance of concrete in terms of properties of fresh and hardened concrete.
5. To understand the concept and optimization of mix design of concrete for different exposure conditions.
6. To enable the students to understand the mechanized and precise procedure of concrete production in Ready Mix Plants. To understand the basic non-destructive tests conducted on concrete to check the in place strength and durability of concrete.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1		**Introduction to building materials and concrete:**	03
	1.1	**Introduction to building materials:** Introduction, role of materials in construction, classification of materials, economical and durable materials.	
	1.2	**Introduction to concrete:** History of concrete, necessity, limitations, merits and demerits.	
2		**Building Materials:**	09
	2.1	**Stones:** Classification and properties of building stones, relation to their structural requirements, quarrying, dressing, seasoning and preservative treatments.	
	2.2	**Bricks and blocks:** Burnt clay bricks: raw materials, manufacturing processes, classification, properties, defects, tests as per BIS codes. Bricks for special use: refractory bricks. Concrete blocks, Paver block, Autoclaved Aerated Concrete (AAC) blocks, Cellular Light Weight Concrete (CLC) blocks and ceramic tiles: raw materials, manufacturing process and properties.	
	2.3	**Glass:** Properties, types, uses.	
	2.4	**Timber:** Types of natural wood and artificial wood, preservative treatments, defects in timber, wood products and wood composites.	
	2.5	Damp proofing, water proofing materials and Termite proofing.	
	2.6	**Mortar:** Types, ingredients, proportions and suitability.	
	2.7	**Paints, Enamels and Varnishes:** Composition. Painting on: plastered surfaces, wood surfaces, meta l surfaces. Effect of weather on: Enamels, distemper, white wash and colour wash, varnish, French polish, Wax Polish.	
	2.8	**Miscellaneous Materials:** Gypsum, Plaster of Paris, Heat and sound insulating materials.	
3		**Constituent of Concrete:**	09
	3.1	**Fine and Coarse Aggregates:** Classification, physical and mechanical propertiesand their influence on the properties of concrete, gradation, Alkali aggregate reaction. Properties of manufacturing sand.	
	3.2	**Cement (OPC):** Grades, Manufacturing, Chemical composition, Hydration of cement, Physical properties as per BIS code. Effects of chemical constituents on the properties of cement. Different types of cement**:** Chemical composition, properties as per relevant IS codes and their applications.	
	3.3	**Water:** Desiredquality of water for concrete.	
	3.4	**Lime:**Types and their usages.	
	3.5	**Admixtures:** Definition and purposes, types of mineral and	

		chemical admixtures. Test on admixtures: chemistry and compatibility with concrete.	
4	**Concrete:**		06
	4.1	Grades, manufacturing process, preparation of batch report, Duff Abram's W/C ratio law & its significance.	
	4.2	Properties of fresh and hardened concrete, factors affecting of workability, vibration of concrete, Types of vibrators: Internal, external, surface and table vibrators.	
	4.3	Durability: factors affecting durability, relation between durability and permeability, laboratory tests on durability such as Permeability test, Rapid chloride penetration test (RCPT).	
5	**Concrete Mix Design:**		08
	5.1	Definition and objectives, Types of mix as per IS:456, Mix design for compressive strength and flexural strength in accordance with IS 10262 and IS 456.	
	5.2	Methods of Curing of concrete, Methods of determining compressive Strength of accelerated-cured concrete test specimens as per IS 9013, Calculation of ingredients of concrete for batching as per concrete mix proportions for different grades.	
6	**Concreting Methods and Test**		04
	6.1	**Ready Mixed Concrete:** Advantages of RMC, Components and Lay-out of RMC plant. Distribution and Transport, Handling and Placing. Codes recommendations.	
	6.2	**Non-Destructive Testing:** Need, application and limitation, Schmidt Rebound hammer test, Ultrasonic Pulse Velocity test.	

Contribution to Outcome

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

1. To develop and implement the conceptual knowledge of building materials in the construction industry.
2. Assess the properties of building stones and their classifications. Understand the concept of various methods of manufacturing of bricks and different types of concrete blocks.
3. To expose students to various quality control aspects of civil engineering materials by performing different lab tests on materials.
4. Identify the ingredients and properties of fresh and hardened concrete.
5. To interpret and design concrete mix for various grades for various exposure conditions.
6. To study the new technology for manufacturing, testing and quality of concrete.

Internal Assessment (20 Marks):

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

End Semester Examination (80 Marks):

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

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be compulsory and should cover **maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only **Four questions need to be solved.**

Recommended Books:

1. A Building Construction: S.*C. Rangwala,* Charotar Publications, Gujarat, India.
2. Building Construction: *S.P. Arora, Dr.S.P. Bindra,*DhanpatRai Publication, New Delhi.
3. Building Construction: *Dr. B.C. Punmia, A.K.Jain, A.R.Jain,*Laxmi Publication., New Delhi.
4. Concrete Technology Theory and Practice: *M.S. Shetty, S.*Chand Publication.
5. Concrete Technology: *M.L. Gambhir,* Tata McGraw Hill, NewDelhi.
6. Concrete Technology: *A.M. Neville & J. J. Brooks.,* ELBS-Longman.
7. Concrete Technology: *A.M. Neville & Isaac Pitman,* London.
8. Concrete Technology: *A. R. Shanthakumar,* Oxford University Press.
9. Materials of Construction: *D. N. Ghose,* Tata McGraw Hill, Delhi.
10. Building Materials: *S.K. Duggal,* New Age International Publishers.
11. Concrete Technology: *D. F. Orchardi,* Wiley, 1962.
12. Relevant codes: BIS, ACI & BS.

Reference Books/Reference Materials:

1. Engineering Materials: *S.R. Rangwala,*Charotar Publications.
2. Architectural Materials science: D. Anapetor, Mir Publishers.
3. Introduction to Engineering Materials: B. K. Agrawal, Tata McGraw Hill, NewDelhi.
4. Engineering Materials: P. Surendra Singh, Vani Education Books,New Delhi.
5. Building Materials (Products, Properties and Systems): M.L. Gambhir and NehaJamwal,McGraw Hill Publications.
6. Properties of concrete: Neville, Isaac Pitman, London.
7. NPTEL Lecture series on Building Materials and Concrete Technology.

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Semester- IV

Course Code	Course Name	Credits
CEC405	Fluid Mechanics - II	03

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

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

Rationale

The course introduces the fluid flow science, problems and their applications in varied conditions. The study deals with the characteristics of fluid flow in pipes namely compressible, laminar and turbulent with their applications in detail.

Objectives

The students will be able to learn:

1. The knowledge of closed conduit flows, determine various losses through pipes, Pipe network and Water hammer effect
2. Theory of Laminar flow and Turbulent flow,
3. Understand the concept of Boundary Layer theory, flow separation and forces around submerged bodies
4. Application of moment of momentum principle on pipe bends and sprinklers
5. The importance of dimensionless numbers, dimensional analysis and similarities.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1	**Flow through pipes**		14
	1.1	**Flow through pipes:** Loss of head through pipes, Darcy-Weisbach equation, Major and minor losses. Hydraulic gradient line and Total energy gradient line, pipes in series,equivalent pipes, pipes in parallel, flow through laterals, flow through Branched pipes, three reservoir problem, siphon.	
	1.2	**Pipe network and water hammer:** Hardy cross method, water hammer in Pipes-Gradual closure and instantaneous closure of valve control measures	

	1.3	**Flow through nozzles:** Power transmitted through nozzle, condition for maximum power transmitted,diameter of nozzle for maximum transmission of power	
2	**Laminar Flow**		**05**
	Reynolds experiment, critical velocity, laminar flow through circular pipes, flow between two parallel plates: stationary and moving.		
3	**Turbulent Flow**		**04**
	Causes of turbulence, shear stress in turbulent flow, Reynolds's stresses, Prandtl's mixing length Theory, Hydro dynamically smooth and rough boundaries, velocity distribution in smooth and rough pipes, Karman-Prandtl's velocity distribution equation.		
4	**Boundary Layer Theory**		**07**
	Development of boundary layer over flat surfaces. Boundary layer thickness, energy thickness and momentum thickness, Boundary layer separation and control. Introduction to flow around submerged body, drag and lift, terminal velocity of body, Magnus Effect.		
5	**Dynamics of Fluid Flow**		**04**
	Momentum principle, Moment of momentum principle (applications: Pipe bends and sprinklers).		
6	**Dimensional Analysis**		**05**
	Dimensional homogeneity, Buckingham's π theorem, Rayleigh's method, dimensionless numbers and their significance, Model (or similarity) laws, application of model laws: Reynolds's model law, Froude's model law, Euler's Model law, Weber's Model law, Mach model law, scale effect in models.		
Total			**39**

Contribution to Outcome

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

1. Analyze flow through pipes, various losses through pipes, pipe network and power transmission through nozzle
2. Explain the concept of Laminar flow and velocity distribution through parallel plates and pipes
3. Explain the concept of Turbulent flow and velocity distribution in pipes
4. Describe boundary layer concept , boundary layer separation and flow around submerged bodies
5. Apply Moment of Momentum Principle

6. Explain the importance of dimensionless numbers, dimensional analysis and similarity behavior of model and prototype

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests:**

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

End Semester Examination (80 Marks):

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

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

Recommended Books:

1. Hydraulics and Fluid mechanics: Dr P.M. Modi and Dr. S.M. Seth, Standard book House, Delhi
2. Theory and Application of Fluid Mechanics: K. Subramanya, Tata McGraw hill publishing company
3. Fluid Mechanics: Dr. A.K Jain, Khanna Publishers.
4. Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
5. Fluid Mechanics and Hydraulics: Dr. S. K. Ukarande, Ane Books Pvt. Ltd. (Revised Edition, 2012), ISBN97893 8116 2538
6. Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.
7. Fluid Mechanics and Machinery: C.S.P.Ojha, R. Berndtsson and P.N. Chandramouli. Oxford HigherEducation.

Reference Books:

1. Fluid Mechanics: Frank M. White, Tata Mc-Graw-Hill International edition.
2. Fluid Mechanics: Streeter White Bed ford, Tata McGraw International edition.
3. Fluid Mechanics with engineering applications: R.L. Daugherty, J.B.Franzini, E.J.,Finnemore, TataMcGraw Hill New Delhi.
4. Hydraulics: James F. Cruise, Vijay P. Singh and Mohsen M. Sherif, CENGAGE Learning India Pvt. Ltd.,Delhi.

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Semester- IV

Course Code	Course Name			Credits		
CEL401	Structural Analysis Tutorial			01		
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	02	-	-	01	-	01

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

Objectives:

1. To analyse for axial force in the Coplanar, perfect trusses and analysis of 3- Hinged arches.
2. To study the concept of Influence Line Diagrams and rolling loads.
3. To learn methods for evaluating rotation and displacement of frames and trusses.
4. To analyse the indeterminate structures using Flexibility methods and Stiffness methods.
5. To understand Plastic analysis.

Outcomes:

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

1. Calculate axial forces in the Coplanar trusses by using Method of joints and method of sections and also calculate radial shear, normal thrust and bending moment in parabolic 3-Hinged arches.
2. Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them..
3. Evaluate rotation and displacement at a joint of frames and deflection at any joint of truss and will be able to compute static and kinematic indeterminacy of structure.
4. Analyse the indeterminate structures such as beams & simple rigid jointed frames using Flexibility methods and direct stiffness method.

List of Tutorials and Assignments		
Week (Activity)	**Content**	**Hours**
1st week (Tutorial)	Analysis of Trusses and Three hinged elastic arches (Numericals based on this Module will be solved in tutorial room.)	**2**

2nd week (Assignments)	1) Analysis of Trusses and Three hinged elastic arches 2) Solve set of questions given by the course instructor or 3) Write a report on use of arches in civil engineering or 4) Difference in behaviour of trusses and arches if used in bridges or 5) Write a report on limitations of trusses /arches or 6) Report Famous Truss structures / arch structures in world or 7) 6 Write a report on use of trusses in Civil Engineering	**2**
3rd week (Tutorial)	Influence line diagrams and rolling loads (Numericals based on this Module will be solved in tutorial room.)	**2**
4th week (Assignments)	Influence line diagrams and rolling loads 1) Solve set of questions given by the course instructor or 2) Write a report on use of arches in civil engineering or 3) Design an experiment for ILD of reactions of beam. or 4) Design an experiment for ILD of axial forces of a multi-bay truss. or 5) write a report on IRC and classes of rolling loads	**2**
5th week (Tutorial)	Determinate and Indeterminate structure (Numericals based on this Module will be solved in tutorial room.)	**2**
6 th week (Assignments)	Determinate and Indeterminate structure 1) Solve set of questions given by the course instructor or 2) Prepare a chart explaining static and kinematic indeterminacy or 3) Write a computer program in C++ or MS-excel or similar for ILD of reactions. or 4) Write a computer program in C++ or MS-excel or similar for ILD for axial forces in Truss members.	**2**
7th week (Tutorial)	Analysis of indeterminate structures by Flexibility method (Numerical based on this Module will be solved in tutorial room.)	**2**
8th week (Assignments)	Analysis of indeterminate structures by Flexibility method 1) Solve set of questions given by the course instructor or 2) Prepare a poster on Flexibility and Stiffness approach or 3) Solve a set of 4-5 questions given by the course instructor on Flexibility methods and validate the same using relevant Structural Analysis or design software.	**2**
9th week (Tutorial)	Analysis of indeterminate structures by Direct stiffness method (Numericals based on this Module will be solved in tutorial room).	**2**
10th week (Assignments)	Analysis of indeterminate structures by Direct stiffness method 1) Solve set of questions given by the course instructor or 2) Write a report on Stiffness methods in civil engineering or 3) Prepare a poster on Clapeyron's theorem for continuous beam.or 4) Solve a set of 4-5 questions given by the course instructor on Direct stiffness method and validate the same using relevant Structural Analysis or design software.	**2**

11th week (Tutorial)	Moment distribution method, Plastic analysis of structures (Numerical based on this Module will be solved in tutorial room.)	**2**
12th week (Assignments)	Moment distribution method, Plastic analysis of structures 1) Solve set of questions given by the course instructor or 2) Write a report on Plastic analysis of structures or 3) Solve a set of 4-5 questions given by the course instructor on Moment distribution method and validate the same using relevant Structural Analysis or design software.	**2**
13th week	Viva-Voce Examination	**2**

- **Assessment:**

Term Work: Term work will include Tutorial work and Assignments both, Distribution of marks for Term Work shall be as follows:

Tutorial work- : 15 Marks
Assignments- : 10 Marks
Total Term work : 25 Marks
Attendance : Apply multiplying Factor 0.5 to 1.0 to the above total.

End Semester Oral Examination

Oral examination will be based on entire syllabus.

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Semester- IV

Course Code	Course Name	Credits
CEL402	Surveying(Lab)	1.5

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

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	50	-	25	75

@ For the course "Surveying (Lab)" the oral examination shall be conducted in conjunction with the practical conduction.

Course Objectives:

The students will be able to learn:

1) Various surveying instruments, their least counts, various parts and suitable uses.
2) Methods of measurements in the field.
3) Skills for collecting, recording and analysing the field data.
4) Advanced instruments and methods.
5) First hand practical experience by receiving field exposure to collect site specific data.
6) Setting out techniques.

Course Outcomes:

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

1) Operate and use the surveying instruments according to the accuracy and suitability.
2) Measure linear and angular dimensions in horizontal and vertical planes.
3) Collect, record and analyse the field data systematically.
4) Prepare plans of the existing features on the ground, sections and contours.
5) Compute the area of land and the volume of earthwork.
6) Set out curves and foundation plans.

List of practical's and projects:

Perform minimum **six** practical's out of 01 to 10 and all the projects are **mandatory**

Module	**Detailed Contents**	**Lab Sessions/Hr**
1	Chain and cross staff surveying.	03 hrs
2	Measuring bearings of a closed traverse with prismatic compass and computation of interior angles.	03 hrs
3	Simple and compound levelling	03 hrs
4	Measurement of horizontal and vertical angles.	03 hrs
5	Finding constants, heights and distances using tachometry.	03 hrs
6	Measurement of distances, bearings and area using total station.	03 hrs
7	Plane Table Surveying by intersection method.	03 hrs
8	Find an area of irregular figure using a conventional planimeter and verify it using a digital planimeter.	03 hrs
9	Setting out a simple curve by Rankine's method.	03 hrs
10	Setting out a simple foundation plan.	03 hrs
Projects		
A survey camp of three days is to be arranged to execute the following projects for undergoing the students through practical instructions in civil engineer's career with the actual field exposure at an ideal site location .		
1	**Project I:** Road project using Auto level for a minimum length of 500 m including fixing of alignment, profile levelling, cross-sectioning at 20m interval,, plotting of 'L' section and 'C' section. (Two full imperial sheets, the first sheet with key plan and 'L' section and the second sheet covering any three typical Cross-sections)	
2	**Project II:** Block Contouring project using Auto level for minimum 60 m × 60 m area and generating contours by MS Excel. (Take contour interval as 0.2 meter)	
3	**Project III:**Tachometric contouring project on a hilly area with at least two instrument stations about 60 m to 100 m apart and generating contours by taking contour intervals as 1 meter.	

Assessment:

Teamwork

Including above practical work, projects and assignments, distribution of marks for Term Work shall be as follows:

Practical Work**-**	:	15 marks
Assignments -	:	05 marks
Attendance-	:	05 marks
Projects-		
Field work	:	15marks
Office work (Drawings)	:	10marks
Total	**:**	**50marks**

- **End Semester Practical/ Oral Examination**

Practical Examination : 10 Marks

Oral Examination : 15 Marks.

Oral examination will be conducted after conduction of practical examination & it will be based on term work & Practical examination

Reference Books:

1) Surveying and Levelling *: R. Agor, Vol-I, 11th Edition*, Khanna Publishers (ISBN 8174092358)
2) Surveying and Levelling :*Kanetkar and Kulkarni,*Vol-I, 24th Edition, Pune VidyarthiGriha, Pune. (ISBN 8185825114)
3) Surveying and Levelling : *Dr. B.C. Punmia,* Vol.-I, 16th Edition, Vol -II 4th Edition*,* Laxmi Publications (ISBN9788170088530)
4) Surveying and Levelling: *N NBasak*, 2nd Edition, Tata McGraw Hill, New Delhi. (ISBN 9789332901537)
5) Surveying: Vol-I: Dr K.R. Arora, Standard Book House.
6) Surveying and Levelling (2nd Edition): R. Subramanian; Oxford Higher Education.
7) Surveying and Levelling (Vol.-I): S.K. Duggal, Tata Mc-Graw Hill

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Semester- IV

Course Code	Course Name	Credits
CEL 403	Building Materials & Concrete Technology (Lab)	01

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

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

Objectives:

1) To determine physical and mechanical properties of materials used in the manufacturing of concrete like cement and aggregates.
2) To test the physical attributes and mechanical strength of burnt clay bricks used in the construction of structures.
3) To determine the various properties of fresh and hardened concrete with and without the addition of admixtures.
4) To study the different basic non-destructive tests conducted in the laboratory or on site to determine the durability and strength of existing concrete structures.
5) To utilize the knowledge of mix design in the manufacturing of concrete, in the laboratory.
6) To test the physical attributes and mechanical strength of timber and tiles used in the construction of various components of the structure.
7) To understand the practical scenario of the commonly used building materials in terms of their availability, cost and significance through market surveys.

Outcomes: Learner will be able to…

1) Develop collaborative skills to work in a team/group
2) Test physical properties of cement, aggregates and concrete.
3) Test various other building materials like tiles, bricks and timber
4) Evaluate the effects of admixtures on physical properties of concrete.
5) Design the concrete mix.
6) To bridge the gap between theoretical and market/industrial practices by market surveys.

List of Experiments (first seven are compulsory)

Module	Detailed Contents	Lab Sessions/Hr
1	Physical properties of OPC: Physical test, Fineness, Standard consistency, Soundness, Setting time, Compressive strength.	**02/04**
2	Physical Properties of Fine and Course Aggregates: Specific gravity, bulk density, Moisture content, Water absorption, flakiness index, elongation index, Fineness modulus, Silt content and bulking of sand	**02/04**
3	Tests on burnt clay bricks	**01/02**
4	Effect of w/c ratio on workability (slump cone, compaction factor, V-B test, flow table) and strength of concrete	**02/04**
5	Study of admixtures and their effect on workability and strength of concrete.	**01/02**
6	Non-destructive testing of concrete: Rebound hammer and ultrasonic pulse velocity	**01/02**
7	Concrete mix design in the laboratory	**01/02**
8	Test on tiles(optional)	**01/02**
9	Compression test on timber (Parallel/ perpendicular to the grains). (optional)	**01/02**
10	Market survey on common building materials (optional)	**01/02**

Site Visit/ Industrial Visit:

The students shall visit the brick, paver blocks, concrete block, cement, glass and RMC industrial plants. They shall prepare a report of the visit and the same shall be evaluated by the concerned teacher.

Assessment:

The term work shall consist of:

- Report of experiments performed.
- Industrial visit report to at least **any one** of the above mentioned industrial plants.
- Although minimum numbers of market surveys and industrial visits are prescribed, the students shall be encouraged to perform more number of experiments and site/ industrial visits.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work including industrial/ site visit report. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Individual Practical performance **:** 07 Marks

Assignments : 03 Marks

Reports of experiment **:** 05 Marks

Site Visit/Industrial visit	:	05 Marks
Attendance	:	05 Marks
Total	**:**	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted tom75% - 80%: 03 Marks; 81% - 90%: 04 Marks; 91% onwards: 05 Marks.

End Semester Practical/Oral Examination

The oral examination shall be based on the entire syllabus and term work comprising of the report of the experiments/ practical conducted by the students and a detail report of the industrial/ site visit.

Recommended Books:

1) A Building Construction: S.*C. Rangwala,* Charotar Publications, Gujarat, India.
2) Building Construction: S.P. Arora, Dr.S.P. Bindra,DhanpatRai Publication, New Delhi.
3) Building Construction: Dr. B.C. Punmia, A.K.Jain, A.R.Jain,Laxmi Publication., New Delhi.
4) Concrete Technology Theory and Practice: M.S. Shetty, S.Chand Publication.
5) Concrete Technology: M.L. Gambhir, Tata McGraw Hill, NewDelhi.
6) Concrete Technology: A.M. Neville & J. J. Brooks., ELBS-Longman.
7) Concrete Technology: A.M. Neville & Isaac Pitman, London.
8) Concrete Technology: A. R. Shanthakumar, Oxford University Press.
9) Materials of Construction: D. N. Ghose, Tata McGraw Hill, Delhi.
10) Building Materials: S.K. Duggal, New Age International Publishers.
11) Concrete Technology: D. F. Orchardi, Wiley, 1962.
12) Relevant codes: BIS, ACI & BS.

Reference Books/Reference Materials:

1) Engineering Materials: *S.R. Rangwala,*Charotar Publications.
2) Architectural Materials science: D. Anapetor, Mir Publishers.
3) Introduction to Engineering Materials: B. K. Agrawal, Tata McGraw Hill, NewDelhi.
4) Engineering Materials: P. Surendra Singh,Vani Education Books, New Delhi.
5) Building Materials (Products, Properties and Systems): M.L. Gambhir and NehaJamwal, McGraw Hill Publications.
6) Properties of concrete: Neville, Isaac Pitman, London.
7) NPTEL Lecture series on Building Materials and Concrete Technology.

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Semester- IV

Course Code	Course Name	Credits
CEL404	Fluid Mechanics – II (Lab)	01

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

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

Course Objectives:

The students will be able to learn:

1) to verify the basic fluid mechanics concepts experimentally
2) the fluid flow pattern in pipes
3) to estimate the losses in pipe flow
4) the velocity distribution in pipes

Course Outcomes:

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

1) Verify the Reynold's experiment
2) Estimate the viscosity of fluid
3) Calculate the losses in pipes
4) Assess the flow pattern and velocity distribution in pipe flow
5) learn the water hammer phenomenon through demonstration
6) learn the wind tunnel testing through demonstration

List of Experiments (Minimum Six)

Module	Detailed Contents	Lab Sessions/Hr
1	Study of different types of flow using Reynold's apparatus	02 hrs
2	Determination of viscosity of fluid	02 hrs
3	Estimation of the head loss due to friction incurred by a fluid along a pipeline (To find the friction factor for the given pipes of different sizes)	04 hrs
4	To determine different losses in pipe fittings (Estimation of the minor losses)	04 hrs
5	Laminar flow through pipes	02 hrs
6	Velocity distribution in circular pipes	04 hrs
7	Turbulent flow through pipe	02 hrs
8	Study of Water Hammer phenomenon	04 hrs
9	Study of wind tunnel	02 hrs

Assessment:

- **Term Work**

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

Laboratory work-	:	15 Marks
Assignments-	:	05 Marks
Attendance	:	05 Marks

- **End Semester Oral Examination**

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Reference Books:

1) Fluid Mechanics and Hydraulic Machines: R. K. Rajput, S. Chand and Company
2) Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi
3) Hydraulics Fluid Mechanics and Fluid Machines: S. Ramamrutham, DhanpatRai Publishing Company (P) Ltd-New Delhi
4) Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
5) Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
6) Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
7) Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

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Semester- IV

Course Code	Course Name	Credits
CEL405	Skill Based Lab Course-II Total Station and Geographical Information System	1

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

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

Objectives:

1) To enable the learners, operate the Total Station and generate its output in terms of plans, elevations and 3D views
2) To enable the learners, operate the Global Navigation Satellite System (GNSS) receivers and retrieve the information
3) To enable the learners work on a Geographical Information System (GIS) platform for assimilating geographical data

Outcomes: Learner will be able to…

1) Operate a Total Station and traverse the field
2) Perform various operations like computing height of a structure, computing area of plot, subdividing area, demarcating boundaries, etc. Using Total Station
3) Set out foundation plan using Total Station
4) Compute the point, line and area features using Global Navigation Satellite System
5) Plot various existing features in a geographic area on a GIS platform
6) Add attribute and perform various statistical operations in GIS

List of Experiments (Minimum Eight)

Module	Detailed Contents	Lab Sessions/Hr
1	Introduction to concepts, fundamental features and working principal of Total Station (TS)	02
2	Temporary settings of a TS in field and perform basic functions on	02

	total station like traversing, area of open plot, height calculations, etc.	
3	Collect detailed features of a plot (comprising features such as 2-3 buildings, courtyards, security cabins, playgrounds, trees, gates, poles, roads, drainage lines, etc.) using TS	04
4	Transfer data collected through TS on a convenient computer aided drafting (CAD) software	02
5	Feeding a CAD plan in TS and setting out a foundation plan using TS	02
6	Introduction to fundamental features of Global Navigation Satellite System (GNSS) and collect point, line and polygon features through a GNSS receiver	02
7	Computing latitudes, longitudes, altitudes of points, length of roads, area of plots, etc. using a GNSS system	02
8	Basic introduction to compatibilities, utilities and attributes of peculiar Geographical Information System (GIS) softwares available in market w.r.t their various commands, features, capabilities and functions.	02
9	Collecting ground points through GNSS and TS for integrating it with spatial data obtained from a GIS platform like google earth, openstreetnetwork, etc. and developing a model on a GIS software	04
10	Add various layers in term of attributes and perform various statistical operations and queries in GIS	04

Assessment:

- **Term Work**

Including Laboratory Work comprising of minimum 8 software generated sheets distribution of marks for Term Work shall be as follows:

Laboratory work : 40 Marks (comprising of min 8 software generated sheets: 4 using TS and GNSS data in CADD tool and 4 using GIS tool)

Attendance : 10 Marks

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Semester- IV

Course Code	Course Name	Credits
CEM 401	Mini Project -1B	1.5

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

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

Objectives
1) To acquaint with the process of identifying the needs and converting it into the problem.
2) To familiarize the process of solving the problem in a group.
3) To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4) To inculcate the process of self-learning and research.

Outcome: Learner will be able to…
1) Identify problems based on societal /research needs.
2) Apply Knowledge and skill to solve societal problems in a group.
3) Develop interpersonal skills to work as member of a group or leader.
4) Draw the proper inferences from available results through theoretical/ experimental/simulations.
5) Analyse the impact of solutions in societal and environmental context for sustainable development.
6) Use standard norms of engineering practices
7) Excel in written and oral communication.
8) Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9) Demonstrate project management principles during project work.

Guidelines for Mini Project

1) Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2) Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
3) Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
4) A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

5) Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
6) Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
7) Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
8) The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
9) With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
10) However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05
    -

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

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
- First shall be for finalisation of problem
- Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
- First review is based on readiness of building working prototype to be conducted.

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

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1) Quality of survey/ need identification
2) Clarity of Problem definition based on need.
3) Innovativeness in solutions
4) Feasibility of proposed problem solutions and selection of best solution
5) Cost effectiveness
6) Societal impact
7) Innovativeness
8) Cost effectiveness and Societal impact
9) Full functioning of working model as per stated requirements
10) Effective use of skill sets
11) Effective use of standard engineering norms
12) Contribution of an individual's as member or leader
13) Clarity in written and oral communication

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

Guidelines for Assessment of Mini Project Practical/Oral Examination:

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

Mini Project shall be assessed based on following points;

1) Quality of problem and Clarity
2) Innovativeness in solutions
3) Cost effectiveness and Societal impact
4) Full functioning of working model as per stated requirements
5) Effective use of skill sets
6) Effective use of standard engineering norms
7) Contribution of an individual's as member or leader
8) Clarity in written and oral communication

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Item No: 125
AC- 23/7/2020

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Civil Engineering

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

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

Under

FACULTY OF SCIENCE & TECHNOLOGY

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

Item No: -125
AC- 23/7/2020

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Civil Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	**U.G.**
7	Pattern	**Semester**
8	Status	**New**
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date

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

Preamble

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

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

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

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

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

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

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

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

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

Preface

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

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

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

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

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

Board of Studies in Civil Engineering, University of Mumbai

1. Dr. S. K. Ukarande:	Chairman
2. Dr. K. K. Sangle:	Member
3. Dr. S. B. Charhate:	Member
4. Dr. A. R. Kambekar:	Member
5. Dr. R. B. Magar:	Member
6. Dr. Seema Jagtap:	Member

Second Year Civil Engineering
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester – IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
CEC401	Engineering Mathematics - IV	3	--	1	3	-	1	4
CEC402	Structural Analysis	4	--	-	4	-	-	4
CEC403	Surveying	3	--	-	3	-	-	3
CEC404	Building Materials & Concrete Technology	3	--	-	3	-	-	3
CEC405	Fluid Mechanics-II	3	-	-	3	-	-	3
CEL 401	Structural Analysis	--	2	-	-	1	-	1
CEL 402	Surveying	--	3	-	-	1.5	-	1.5
CEL 403	Building Material Concrete Technology	--	2	-	-	1	-	1
CEL 404	Fluid Mechanics-II	--	2			1		1
CEL 405	Skill Based lab Course	--	2	-	-	1	-	1
CEM401	Mini Project – 1 B	--	3$	-	-	1.5	-	1.5
Total		**16**	**14**	**1**	**16**	**7**	**1**	**24**

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)-	Term Work	Prac. /Oral	Total
		Test I	Test II	Avg.					
CEC 401	Engineering Mathematics - IV	20	20	20	80	3	25	-	125
CEC 402	Structural Analysis	20	20	20	80	3	-	-	100
CEC 403	Surveying	20	20	20	80	3	-	-	100
CEC 404	Building Materials & Concrete Technology	20	20	20	80	3	-	-	100
CEC 405	Fluid Mechanics-II	20	20	20	80	3	-	-	100
CEL 401	Structural Analysis						25	25	50
CEL 402	Surveying						50	25	75
CEL 403	Building Materials & Concrete Technology	-	-	-	-	-	25	25	50
CEL 404	Fluid Mechanics-II	-	-	-	-	-	25	25	50
CEL 405	Skill Based lab Course	-	-	-	-	-	50	-	50
CEM401	Mini Project – 1 B	-	-	-	-	-	25	25	50
	Total			**100**	**400**	**-**	**225**	**125**	**850**

Semester- IV

Course Code	Course Name	Credits
CEC 401	Engineering Mathematics-IV	04

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	01	03	-	01	04

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem. Exam	TW	PR	OR	
Test-I	Test-II	Average						
20	20	20	80	03 hrs	25	-	-	125

Pre-requisite:

- Engineering Mathematics-I,
- Engineering Mathematics-II,
- Engineering Mathematics-III,

Objectives:

1) To study the concept of Vector calculus & its applications in engineering.
2) To study Line and Contour integrals and expansion of complex valued function in a power series.
3) To familiarize with the concepts of statistics for data analysis.
4) To acquaint with the concepts of probability, random variables with their distributions and expectations.
5) To familiarize with the concepts of probability distributions and sampling theory with its applications.

Outcomes: Learner will be able to….

1) Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's theorem & Gauss Divergence theorem.
2) Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3) Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.
4) Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
5) Apply the concept of probability distribution to engineering problems& Testing hypothesis of small samples using sampling theory
6) Apply the concepts of parametric and nonparametric tests for analysing practical problems.

Module	Detailed Contents	Hrs.
01	**Module : Vector Calculus** 1.1 Solenoidal and irrotational (conservative) vector fields. 1.2 Line integrals – definition and problems. 1.3 Green's theorem (without proof) in a plane, Stokes' theorem (without Proof), Gauss' Divergence theorem (without proof) and problems (only evaluation). **<u>Self Learning Topics</u>**: Identities connecting Gradient, Divergence and Curl, Angle between surfaces. Verifications of Green's theorem, Stoke's theorem & Gauss-Divergence theorem, related identities & deductions.	**07**
02	**Module: Complex Integration** 2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 2.2 Taylor's and Laurent's series (without proof). 2.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof) **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	**07**
03	**Module: Statistical Techniques** 3.1 Karl Pearson's Coefficient of correlation (r) and related concepts with problems 3.2 Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems) 3.3 Lines of regression 3.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	**06**
04	**Module: Probability Theory:** 4.1 Conditional probability, Total Probability and Baye's Theorem. 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, 4.3 Expectation, Variance, Co-variance, moments, Moment generating functions, (Four moments about the origin &about the mean). **<u>Self- learning Topics</u>:** Properties variance and covariance,	**06**
05	**Module: Probability Distribution and Sampling Theory-I** 5.1 Probability Distribution: Poisson and Normal distribution 5.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 5.3 Students' t-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t- test) **<u>Self -learning Topics</u>:** Test of significance of large samples, Proportion test, Survey based project.	**07**
06	**Module: Sampling theory-II** 6.1 Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate's Correction. 6.2 Analysis of variance: F-test (significant difference between variances of two samples) **<u>Self- learning Topics</u>:** ANOVA**:** One way classification, Two-way classification (short-cut method).	**06**

Term Work:

General Instructions:

1) Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practical.
2) Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3) A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1	Attendance (Theory and Tutorial)	05 marks
2	Class Tutorials on entire syllabus	10 marks
3	Mini project	10 marks

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

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

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

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Vector Analysis, Murray R. Spiegel, Schaum Series
5. Complex Variables and Applications, Brown and Churchill, McGraw-Hilleducation
6. Probability Statistics and Random Processes, T. Veerarajan, Mc. GrawHilleducation.

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<table>
<tr><th colspan="3">Semester-IV</th></tr>
<tr><th>Course Code</th><th>Course Name</th><th>Credits</th></tr>
<tr><td>CEC402</td><td>Structural Analysis</td><td>4</td></tr>
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<table>
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<tr><th colspan="5">Theory</th><th colspan="3">Term Work/Practical/Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal Assessment</th><th rowspan="2">End Sem. Exam</th><th rowspan="2">Duration of End Sem. Exam</th><th rowspan="2">TW</th><th rowspan="2">PR</th><th rowspan="2">OR</th></tr>
<tr><th>Test-I</th><th>Test-II</th><th>Average</th></tr>
<tr><td>20</td><td>20</td><td>20</td><td>80</td><td>3 hrs</td><td>-</td><td>-</td><td>-</td><td>100</td></tr>
</table>

Rationale

Different components of civil engineering structures are subjected to variousforce systems and their combinations. For designing the components, these are analyzed for their response. The structural systems are determinate or indeterminate in nature and so there are different analysis methods.These will be learnt in this course. Subject knowledge of Engineering Mechanics and Mechanics of solids is the prerequisite of this course.
Their application on solids and mechanisms, the action of force systems is studied and further extended in this subject. Learner will learn to apply these to the analysis of various members of structural systems such as beams, trusses, portal frames and arches. These analyses will further be used while designing of Steel and RCC structures.

Objectives

1. To analyze for axial force in the Coplanar, perfect trusses and analysis of 3- Hinged arches.
2. To study the concept of Influence Line Diagrams for Reactions, SF and B M in beams and axial forces in trusses and their application for rolling load systems.
3. To learn methods for evaluating rotation and displacement parameters in respect of frames andtrusses using various methods. To understand static and kinematic indeterminacy of structures.
4. To analyze the indeterminate structures using Flexibility methods and Using Clapeyron’s Theorem..
5. To analyze the indeterminate structures such as beams & simple rigid jointed framesusing direct stiffness method.
6. To analyze the indeterminate structures using Moment Distribution as Stiffness method and Plastic analysis of structures.

Detailed Syllabus			
Module		**Course Modules / Contents**	Duration
1		**Trusses and 3 hinged Arches**	**(9)**
	1. 1	**Trusses**: Analysis of Perfect Coplanar Trusses by Method of Joints (3) Analysis of Perfect Coplanar Trusses by Method of sections.(3)	**6**
	1. 2	**Three hinged elastic arches,** Determination of normal thrust, radial shear and bending moment for Symmetrical & Unsymmetrical parabolic three hinged arches.(3)	**3**
2		**Influence line diagrams and rolling loads**	**(09)**
	2. 1	Influence lines for Reactions, shear force and bending moment at a section of cantilever, simply supported, overhanging beams without internal hinges. (2) Rolling loads, Determination of S F and BM at a section, Value and criteria for maximum shear force and bending moment, absolute maximum shear force and bending moment under rolling loads (UDL and series of point loads) for simply supported girder. (4)	**6**
	2. 2	I L D for Axial forces in members of Pin jointed trusses (3)	**3**
3		**Determinate and Indeterminate structures**	**(8)**
	3. 1	Deflection of Statically determinate structures, methods based on energy principles and Castigliano's theorems to evaluate deflection in portal frames, bent up and arch type structures. Application of Unit Load Method for calculating slope and deflection of a point on rigid jointed frames and deflection of a point on Pin jointed truss.	**5**
	3. 2	Static and kinematic indeterminacies: Types of structures occurring in practice, their classification, linear and non-linear behavior of materials, geometric non-linearity, static and kinematic determinacy and indeterminacy of structure.	**3**
4		**Analysis of indeterminate structures by Flexibility method**	**(9)**
	4.1	Analysis of fixed beam. Application of Clapeyron's theorem of three moments to fixed beam and continuous beam.	**4**
	4.2	Flexibility coefficients and their use in formulation of compatibility equations. Application of flexibility method to propped cantilevers, fixed beams & continuous beams, Simple rigid jointed frames.	**5**
5		**Analysis of indeterminate structures by Stiffness method**	**(8)**
	5.1	**Direct stiffness method:** Stiffness coefficients for prismatic members and their use for formulation of equilibrium equations.	**4**
	5.2	Application of Direct stiffness method to indeterminate beams & simple rigid jointed frames.	**4**
6		**Moment distribution method and Plastic Analysis of structures.**	**(9)**

	6.1	**Moment distribution method:** Application to indeterminate beams & simple rigid jointed frames & frame with inclined member but having only single translation degree of freedom including the effect of support settlement.	**5**
	6.2	**Plastic analysis of structures**: Introduction to plastic analysis, concept of plastic hinge, plastic moment carrying capacity, shape factor. Static and kinematic method of plastic analysis.Determination of collapse load for single and multiple span beams.	**4**

Contribution to Outcome

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

1. Calculate axial forces in the Coplanartrusses by using Method of joints and method of sections and also calculate radial shear, normal thrust and bending moment in parabolic 3-Hinged arches.
2. Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them..
3. Evaluate rotation and displacement at a joint of frames and deflection at any joint of truss and will be able to compute static and kinematic indeterminacy of structure.
4. Apply Flexibility methods and make use of Clapeyron's Theorem to analyze the indeterminate structures.
5. Analyse the indeterminate structures such as beams & simple rigid jointed frames using direct stiffness method.
6. Analyse the indeterminate structures using Moment Distribution as Stiffness method and make plastic analysis.

Internal Assessment (20 Marks):
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

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

Recommended Books:

1. Basic Structural Analysis: *C.S. Reddy*, Tata McGraw Hill New Delhi.
2. Mechanics of Structures: Vol-I: S. B. Junnarkar and H.J. Shah, Charotar Publishers, Anand.
3. Analysis of Structures: Vol. I and II, Vazirani and Ratwani

4. Strength of Materials: S. Ramamrutham, Dhanpatrai and Publishers, Delhi
5. Theory of Structures: S. Ramamrutham, Dhanpatrai and Sons, Delhi
6. Structural Analysis I: HemantPatil, YogeshPatil, Jignesh Patel, Synergy Knowledgeware, Mumbai.
7. Strength of Materials: Rajput, S. Chand Publications, Delhi
8. Structural Analysis: Bhavikatti, Vikas publisher house Pvt, ltd.
9. Structural Analysis: DevdasMenon, Narosa Publishing House.
10. Basic Structural Analysis: K.U. Muthu, Azmi Ibrahim, M. Vijyanand,
11. MagantiJanadharnand. I.K.International Publishing House Pvt. Ltd.
12. Comprehensive Structural Analysis: Vol-I and II by Vaidyanathan R. and Perumal R.LaxmiPublications.
13. Elementary Structural Analysis: Jindal
14. Structural Analysis: L.S. Negi and R.S. Jangid, Tata Mc-Graw Hill India
15. Fundamentals of Structural Analysis: Sujit Kumar Roy and SubrotaChakrabarty, S. Chand Publications.
16. Structural Analysis: T.S. Thandavamoorthy, Oxford University Press.
17. Structural Analysis: Manmohan Das, Bharghab Mohan Pentice Hall International. .

Reference Books:

1. Structural Analysis: *Hibbler*, Pentice Hall International.
2. Structural Analysis: *Chajes*, ElBS London.
3. Theory of Structures: *Timoshenko and Young*, Tata McGraw Hill New Delhi.
4. Structural Analysis: *Kassimali*, TWS Publications.
5. Element of Structural Analysis: *Norris and Wilbur*, McGraw Hill.
6. Structural Analysis: *Laursen H.I*, McGraw Hill Publishing Co.
7. Structural theorem and their application: *B.G. Neal*, Pergaman Press.
8. Fundamentals of Structural Analysis: *K.M. Leet*, C.M. Uang and A.M. Gilbert, Tata McGraw Hill, New Delhi.
9. Elementary theory of Structures: *Hseih*, Prentice Hall

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Semester- IV

Course Code	Course Name	Credits
CEC403	Surveying	03

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

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

Rationale

As it is always said "well begun is half done". All civil engineering projects such as buildings, roads, bridges, railways, airports, dams, water treatment plants, sewage treatment plants begin with surveying. Knowledge of surveying is thus fundamental and very useful to all civil engineers. In this course, the students are well informed about the principles and methods of surveying. The students are made conversant with various instruments which are used in the field to take measurements for preparation of drawings. The course introduces the advancements in instruments and methods of surveying. The study deals with the methods of computing land areas and volume of earthworks. The course also covers horizontal and vertical curves.

Objectives

The students will be able to learn:

1. The basic principles and classification of surveying.
2. Various methods of measurements in surveying.
3. The appropriate techniques of surveying and skills of collecting field data for preparing drawings.
4. Advancements in instruments and methods of surveying.
5. The methods of computing areas and volumes using the site specific data for various purposes.
6. The setting out techniques of curves.

Detailed Syllabus

Module	Course Modules/ Contents		Periods
1	**Introduction**		**5**
	1.1	Definition, principles, objectives, fundamental classification-plane and geodetic.	
	1.2	Chaining, Ranging and offsetting: Definitions, Principles, Instruments required, Obstacles, conventional signs and symbols.	
	1.3	Bearings – Different types, compass – prismatic, surveyor, dip,declination and local attraction, compass traversing	
2	**Levelling and Contouring**		**8**
	2.1	Definitions, basic terms, types of instruments-dumpy level and Auto level, principal axes of dumpy level, temporary and permanent adjustments	
	2.2	Booking and reduction of levels, plane of collimation (HI) and rise-fall methods, computation of missing data, distance to the visible horizon,corrections due to curvature and refraction, reciprocal levelling, Numerical problems	
	2.3	Differential levelling, profile levelling, fly levelling, check levelling, precise levelling, sources of errors,difficulties in levelling work, corrections and precautions work in levelling	
	2.4	Contouring: terms, contour, contouring, contour interval, horizontal equivalent Direct and indirect methods of contouring, interpolation of contours, uses of Contours and characteristics of contour lines. Grade contour	
3	**Theodolite Surveying**		**8**
	3.1	Various parts and axes of transit, technical terms, temporary and permanent adjustments of a transit, measurement of horizontal and vertical angles, Methods of repetition and reiteration.	
	3.2	Different methods of running a theodolite traverse, Latitudes and departures,rectangular coordinates,traverse adjustments by Bowditch's, transit and Modified transit rules, Gales Traverse Table, Numerical Problems.	
	3.3	Miscellaneous use of theodolite for various works such as prolongation of a straight line,setting out an angle, bearing measurements.Omitted measurements, Problems in using theodolite traversing, errors in theodolite traversing.	
4	**Indirect and Advanced Methods of Measurement**		**7**
	4.1	Tacheometry-Principle, Objective, Suitability and different methods of tacheometry, Stadia formula, Radial contouring , numerical on stadia method only	
	4.2	Electronic Distance Measurement: Working Principles, types, applications in surveying	
		Total Station- Working Principles, applications in surveying	
	4.3	Introduction to GPS	
	Plane Table Surveying, Areas and Volumes		**5**

5	5.1	Definition, principle, accessories required for plane table surveying, merits and demerits, temporary adjustments, Different methods of plane table surveying	
	5.2	Areas: Area of an irregular figure by trapezoidal rule, average ordinate rule,Simpson's 1/3 rule, various coordinate methods.Planimeter: types including digital planimeter, area of zero circle, uses of planimeter.	
	5.3	Volumes: Computation of volume by trapezoidal and prismoidal formula,volume from spot levels, volume from contour plans.	
6	**Curves**		**6**
	6.1	Horizontal Curves-Definitions of different terms, necessity and types of curves.Methods of setting out Simple circular curves- linear methods and Angular methods (Numericals on simple circular curves only)	
	6.2	Vertical curves– Definitions, geometry and types. Tangent correction and chord gradient methods.	
		Total	**39**

Contribution to Outcomes

After completion of the course, the learner will be able to:

1. 1.Apply the principles of surveying and field procedures to conduct the various surveys
2. Use various methods for taking linear and angular measurements
3. Collect, record and analyse the field data for preparing drawings.
4. Explain the advancements in instruments and methods
5. 5.Calculate the area of land and volume of earthwork
6. Set out curves

Internal Assessment (20 marks):
Consisting **Two Compulsory Class Tests:**
First test based on approximately 40% of the contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 marks):

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

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

Recommended Books:

1. Surveying and Levelling: R. Agor, Vol. -I, 11th Edition, Khanna Publishers (ISBN8174092358)

2. Surveying and Levelling:Kanetkar and Kulkarni, Vol. -I, 24th Edition, Pune Vidyarthi Griha, Pune. (ISBN 8185825114)
3. Surveying and Levelling:Dr. B.C. Punmia, Vol.-I, 16th Edition, Vol. -II 4th Edition, Laxmi Publications (ISBN9788170088530)
4. Surveying and Levelling: N NBasak, 2nd Edition, Tata McGraw Hill, New Delhi. (ISBN 9789332901537)

Reference Books:

1. Surveying: Volume -I: Dr K.R. Arora, Standard Book House.
2. Surveying and Levelling (2nd Edition): R. Subramanian; Oxford Higher Education.
3. Surveying and Levelling (Vol.-I): S.K. Duggal, Tata McGraw Hill
4. Textbook of Surveying, C Venkatramaiah, University Press, Hyderabad, Latest Edition
5. Fundamentals of Surveying, S.K. Roy, Prentice Hall India, New Delhi
6. Surveying for Engineers, John Uraine and Bill Price, Palgrave Macmillan
7. Surveying: Theory and Practice, James Anderson, Edward M. Mikhail, Tata Mcgraw Hill

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Semester - IV

Course Code	Course Name	Credits
CEC 404	Building Materials & Concrete Technology	03

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

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

Rationale

Materials are essential elements, constituent parts (or) substances which are used to raise a building, but materials could not be turned into structures without a method of construction. This course provides necessary knowledge about properties, uses of different types of building materials and the selection of materials, its mix proportioning, mixing, placing, compacting and curing. This course is intended for gaining useful knowledge with respect to facts, concepts, principles and procedures related to building materials and concrete technology so that student can effectively execute quality control during building construction work.

Objectives

1. To identify the good and significant materials to be used for the construction work and their associated quality, durability, warrantees, and availability.
2. To study the manufacturing process, properties and use of different types of building materials like stone, brick, glass, timber and the materials such as paints and varnishes used for the treatment of surfaces so as to achieve good knowledge about the building materials.
3. To acquire a thorough knowledge about the properties and significance of different materials used for the manufacturing of concrete.
4. To study the properties, test conducted and significance of concrete in terms of properties of fresh and hardened concrete.
5. To understand the concept and optimization of mix design of concrete for different exposure conditions.
6. To enable the students to understand the mechanized and precise procedure of concrete production in Ready Mix Plants. To understand the basic non-destructive tests conducted on concrete to check the in place strength and durability of concrete.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1	**Introduction to building materials and concrete:**		03
	1.1	**Introduction to building materials:** Introduction, role of materials in construction, classification of materials, economical and durable materials.	
	1.2	**Introduction to concrete:** History of concrete, necessity, limitations, merits and demerits.	
2	**Building Materials:**		09
	2.1	**Stones:** Classification and properties of building stones, relation to their structural requirements, quarrying, dressing, seasoning and preservative treatments.	
	2.2	**Bricks and blocks:** Burnt clay bricks: raw materials, manufacturing processes, classification, properties, defects, tests as per BIS codes. Bricks for special use: refractory bricks. Concrete blocks, Paver block, Autoclaved Aerated Concrete (AAC) blocks, Cellular Light Weight Concrete (CLC) blocks and ceramic tiles: raw materials, manufacturing process and properties.	
	2.3	**Glass:** Properties, types, uses.	
	2.4	**Timber:** Types of natural wood and artificial wood, preservative treatments, defects in timber, wood products and wood composites.	
	2.5	Damp proofing, water proofing materials and Termite proofing.	
	2.6	**Mortar:** Types, ingredients, proportions and suitability.	
	2.7	**Paints, Enamels and Varnishes:** Composition. Painting on: plastered surfaces, wood surfaces, meta l surfaces. Effect of weather on: Enamels, distemper, white wash and colour wash, varnish, French polish, Wax Polish.	
	2.8	**Miscellaneous Materials:** Gypsum, Plaster of Paris, Heat and sound insulating materials.	
3	**Constituent of Concrete:**		09
	3.1	**Fine and Coarse Aggregates:** Classification, physical and mechanical propertiesand their influence on the properties of concrete, gradation, Alkali aggregate reaction. Properties of manufacturing sand.	
	3.2	**Cement (OPC):** Grades, Manufacturing, Chemical composition, Hydration of cement, Physical properties as per BIS code. Effects of chemical constituents on the properties of cement. Different types of cement**:** Chemical composition, properties as per relevant IS codes and their applications.	
	3.3	**Water:** Desiredquality of water for concrete.	
	3.4	**Lime:**Types and their usages.	
	3.5	**Admixtures:** Definition and purposes, types of mineral and	

		chemical admixtures. Test on admixtures: chemistry and compatibility with concrete.	
4	**Concrete:**		**06**
	4.1	Grades, manufacturing process, preparation of batch report, Duff Abram's W/C ratio law & its significance.	
	4.2	Properties of fresh and hardened concrete, factors affecting of workability, vibration of concrete, Types of vibrators: Internal, external, surface and table vibrators.	
	4.3	Durability: factors affecting durability, relation between durability and permeability, laboratory tests on durability such as Permeability test, Rapid chloride penetration test (RCPT).	
5	**Concrete Mix Design:**		**08**
	5.1	Definition and objectives, Types of mix as per IS:456, Mix design for compressive strength and flexural strength in accordance with IS 10262 and IS 456.	
	5.2	Methods of Curing of concrete, Methods of determining compressive Strength of accelerated-cured concrete test specimens as per IS 9013, Calculation of ingredients of concrete for batching as per concrete mix proportions for different grades.	
6	**Concreting Methods and Test**		**04**
	6.1	**Ready Mixed Concrete:** Advantages of RMC, Components and Lay-out of RMC plant. Distribution and Transport, Handling and Placing. Codes recommendations.	
	6.2	**Non-Destructive Testing:** Need, application and limitation, Schmidt Rebound hammer test, Ultrasonic Pulse Velocity test.	

Contribution to Outcome

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

1. To develop and implement the conceptual knowledge of building materials in the construction industry.
2. Assess the properties of building stones and their classifications. Understand the concept of various methods of manufacturing of bricks and different types of concrete blocks.
3. To expose students to various quality control aspects of civil engineering materials by performing different lab tests on materials.
4. Identify the ingredients and properties of fresh and hardened concrete.
5. To interpret and design concrete mix for various grades for various exposure conditions.
6. To study the new technology for manufacturing, testing and quality of concrete.

Internal Assessment (20 Marks):

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

End Semester Examination (80 Marks):

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

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be compulsory and should cover **maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only **Four questions need to be solved.**

Recommended Books:

1. A Building Construction: S.*C. Rangwala,* Charotar Publications, Gujarat, India.
2. Building Construction: *S.P. Arora, Dr.S.P. Bindra,*DhanpatRai Publication, New Delhi.
3. Building Construction: *Dr. B.C. Punmia, A.K.Jain, A.R.Jain,*Laxmi Publication., New Delhi.
4. Concrete Technology Theory and Practice: *M.S. Shetty, S.*Chand Publication.
5. Concrete Technology: *M.L. Gambhir,* Tata McGraw Hill, NewDelhi.
6. Concrete Technology: *A.M. Neville & J. J. Brooks.,* ELBS-Longman.
7. Concrete Technology: *A.M. Neville & Isaac Pitman,* London.
8. Concrete Technology: *A. R. Shanthakumar,* Oxford University Press.
9. Materials of Construction: *D. N. Ghose,* Tata McGraw Hill, Delhi.
10. Building Materials: *S.K. Duggal,* New Age International Publishers.
11. Concrete Technology: *D. F. Orchardi,* Wiley, 1962.
12. Relevant codes: BIS, ACI & BS.

Reference Books/Reference Materials:

1. Engineering Materials: *S.R. Rangwala,*Charotar Publications.
2. Architectural Materials science: D. Anapetor, Mir Publishers.
3. Introduction to Engineering Materials: B. K. Agrawal, Tata McGraw Hill, NewDelhi.
4. Engineering Materials: P. Surendra Singh, Vani Education Books,New Delhi.
5. Building Materials (Products, Properties and Systems): M.L. Gambhir and NehaJamwal,McGraw Hill Publications.
6. Properties of concrete: Neville, Isaac Pitman, London.
7. NPTEL Lecture series on Building Materials and Concrete Technology.

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Semester- IV

Course Code	Course Name	Credits
CEC405	Fluid Mechanics - II	03

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

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

Rationale

The course introduces the fluid flow science, problems and their applications in varied conditions. The study deals with the characteristics of fluid flow in pipes namely compressible, laminar and turbulent with their applications in detail.

Objectives

The students will be able to learn:

1. The knowledge of closed conduit flows, determine various losses through pipes, Pipe network and Water hammer effect
2. Theory of Laminar flow and Turbulent flow,
3. Understand the concept of Boundary Layer theory, flow separation and forces around submerged bodies
4. Application of moment of momentum principle on pipe bends and sprinklers
5. The importance of dimensionless numbers, dimensional analysis and similarities.

Detailed Syllabus

Module		Course Modules / Contents	Periods
1		**Flow through pipes**	14
	1.1	**Flow through pipes:** Loss of head through pipes, Darcy-Weisbach equation, Major and minor losses. Hydraulic gradient line and Total energy gradient line, pipes in series,equivalent pipes, pipes in parallel, flow through laterals, flow through Branched pipes, three reservoir problem, siphon.	
	1.2	**Pipe network and water hammer:** Hardy cross method, water hammer in Pipes-Gradual closure and instantaneous closure of valve control measures	

	1.3	**Flow through nozzles:** Power transmitted through nozzle, condition for maximum power transmitted,diameter of nozzle for maximum transmission of power	
2	**Laminar Flow**		**05**
	Reynolds experiment, critical velocity, laminar flow through circular pipes, flow between two parallel plates: stationary and moving.		
3	**Turbulent Flow**		**04**
	Causes of turbulence, shear stress in turbulent flow, Reynolds's stresses, Prandtl's mixing length Theory, Hydro dynamically smooth and rough boundaries, velocity distribution in smooth and rough pipes, Karman-Prandtl's velocity distribution equation.		
4	**Boundary Layer Theory**		**07**
	Development of boundary layer over flat surfaces. Boundary layer thickness, energy thickness and momentum thickness, Boundary layer separation and control. Introduction to flow around submerged body, drag and lift, terminal velocity of body, Magnus Effect.		
5	**Dynamics of Fluid Flow**		**04**
	Momentum principle, Moment of momentum principle (applications: Pipe bends and sprinklers).		
6	**Dimensional Analysis**		**05**
	Dimensional homogeneity, Buckingham's π theorem, Rayleigh's method, dimensionless numbers and their significance, Model (or similarity) laws, application of model laws: Reynolds's model law, Froude's model law, Euler's Model law, Weber's Model law, Mach model law, scale effect in models.		
Total			**39**

Contribution to Outcome

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

1. Analyze flow through pipes, various losses through pipes, pipe network and power transmission through nozzle
2. Explain the concept of Laminar flow and velocity distribution through parallel plates and pipes
3. Explain the concept of Turbulent flow and velocity distribution in pipes
4. Describe boundary layer concept , boundary layer separation and flow around submerged bodies
5. Apply Moment of Momentum Principle

6. Explain the importance of dimensionless numbers, dimensional analysis and similarity behavior of model and prototype

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests:**

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

End Semester Examination (80 Marks):

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

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

Recommended Books:

1. Hydraulics and Fluid mechanics: Dr P.M. Modi and Dr. S.M. Seth, Standard book House, Delhi
2. Theory and Application of Fluid Mechanics: K. Subramanya, Tata McGraw hill publishing company
3. Fluid Mechanics: Dr. A.K Jain, Khanna Publishers.
4. Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
5. Fluid Mechanics and Hydraulics: Dr. S. K. Ukarande, Ane Books Pvt. Ltd. (Revised Edition, 2012), ISBN97893 8116 2538
6. Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.
7. Fluid Mechanics and Machinery: C.S.P.Ojha, R. Berndtsson and P.N. Chandramouli. Oxford HigherEducation.

Reference Books:

1. Fluid Mechanics: Frank M. White, Tata Mc-Graw-Hill International edition.
2. Fluid Mechanics: Streeter White Bed ford, Tata McGraw International edition.
3. Fluid Mechanics with engineering applications: R.L. Daugherty, J.B.Franzini, E.J.,Finnemore, TataMcGraw Hill New Delhi.
4. Hydraulics: James F. Cruise, Vijay P. Singh and Mohsen M. Sherif, CENGAGE Learning India Pvt. Ltd.,Delhi.

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Semester- IV

Course Code	Course Name	Credits
CEL401	Structural Analysis Tutorial	01

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

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

Objectives:

1. To analyse for axial force in the Coplanar, perfect trusses and analysis of 3- Hinged arches.
2. To study the concept of Influence Line Diagrams and rolling loads.
3. To learn methods for evaluating rotation and displacement of frames and trusses.
4. To analyse the indeterminate structures using Flexibility methods and Stiffness methods.
5. To understand Plastic analysis.

Outcomes:

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

1. Calculate axial forces in the Coplanar trusses by using Method of joints and method of sections and also calculate radial shear, normal thrust and bending moment in parabolic 3-Hinged arches.
2. Draw Influence Line Diagrams for axial forces in trusses, Reactions, SF and B M in beams and find their values when rolling loads are passing over them..
3. Evaluate rotation and displacement at a joint of frames and deflection at any joint of truss and will be able to compute static and kinematic indeterminacy of structure.
4. Analyse the indeterminate structures such as beams & simple rigid jointed frames using Flexibility methods and direct stiffness method.

List of Tutorials and Assignments		
Week (Activity)	**Content**	**Hours**
1st week (Tutorial)	Analysis of Trusses and Three hinged elastic arches (Numericals based on this Module will be solved in tutorial room.)	**2**

2nd week (Assignments)	1) Analysis of Trusses and Three hinged elastic arches 2) Solve set of questions given by the course instructor or 3) Write a report on use of arches in civil engineering or 4) Difference in behaviour of trusses and arches if used in bridges or 5) Write a report on limitations of trusses /arches or 6) Report Famous Truss structures / arch structures in world or 7) 6 Write a report on use of trusses in Civil Engineering	**2**
3rd week (Tutorial)	Influence line diagrams and rolling loads (Numericals based on this Module will be solved in tutorial room.)	**2**
4th week (Assignments)	Influence line diagrams and rolling loads 1) Solve set of questions given by the course instructor or 2) Write a report on use of arches in civil engineering or 3) Design an experiment for ILD of reactions of beam. or 4) Design an experiment for ILD of axial forces of a multi-bay truss. or 5) write a report on IRC and classes of rolling loads	**2**
5th week (Tutorial)	Determinate and Indeterminate structure (Numericals based on this Module will be solved in tutorial room.)	**2**
6 th week (Assignments)	Determinate and Indeterminate structure 1) Solve set of questions given by the course instructor or 2) Prepare a chart explaining static and kinematic indeterminacy or 3) Write a computer program in C++ or MS-excel or similar for ILD of reactions. or 4) Write a computer program in C++ or MS-excel or similar for ILD for axial forces in Truss members.	**2**
7th week (Tutorial)	Analysis of indeterminate structures by Flexibility method (Numerical based on this Module will be solved in tutorial room.)	**2**
8th week (Assignments)	Analysis of indeterminate structures by Flexibility method 1) Solve set of questions given by the course instructor or 2) Prepare a poster on Flexibility and Stiffness approach or 3) Solve a set of 4-5 questions given by the course instructor on Flexibility methods and validate the same using relevant Structural Analysis or design software.	**2**
9th week (Tutorial)	Analysis of indeterminate structures by Direct stiffness method (Numericals based on this Module will be solved in tutorial room).	**2**
10th week (Assignments)	Analysis of indeterminate structures by Direct stiffness method 1) Solve set of questions given by the course instructor or 2) Write a report on Stiffness methods in civil engineering or 3) Prepare a poster on Clapeyron's theorem for continuous beam.or 4) Solve a set of 4-5 questions given by the course instructor on Direct stiffness method and validate the same using relevant Structural Analysis or design software.	**2**

11th week (Tutorial)	Moment distribution method, Plastic analysis of structures (Numerical based on this Module will be solved in tutorial room.)	**2**
12th week (Assignments)	Moment distribution method, Plastic analysis of structures 1) Solve set of questions given by the course instructor or 2) Write a report on Plastic analysis of structures or 3) Solve a set of 4-5 questions given by the course instructor on Moment distribution method and validate the same using relevant Structural Analysis or design software.	**2**
13th week	Viva-Voce Examination	**2**

- **Assessment:**

Term Work: Term work will include Tutorial work and Assignments both, Distribution of marks for Term Work shall be as follows:

Tutorial work- : 15 Marks
Assignments- : 10 Marks
Total Term work : 25 Marks
Attendance : Apply multiplying Factor 0.5 to 1.0 to the above total.

End Semester Oral Examination

Oral examination will be based on entire syllabus.

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Semester- IV

Course Code	Course Name	Credits
CEL402	Surveying(Lab)	1.5

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

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test-I	Test-II	Average						
-	-	-	-	-	50	-	25	75

@ For the course "Surveying (Lab)" the oral examination shall be conducted in conjunction with the practical conduction.

Course Objectives:

The students will be able to learn:

1) Various surveying instruments, their least counts, various parts and suitable uses.
2) Methods of measurements in the field.
3) Skills for collecting, recording and analysing the field data.
4) Advanced instruments and methods.
5) First hand practical experience by receiving field exposure to collect site specific data.
6) Setting out techniques.

Course Outcomes:

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

1) Operate and use the surveying instruments according to the accuracy and suitability.
2) Measure linear and angular dimensions in horizontal and vertical planes.
3) Collect, record and analyse the field data systematically.
4) Prepare plans of the existing features on the ground, sections and contours.
5) Compute the area of land and the volume of earthwork.
6) Set out curves and foundation plans.

List of practical's and projects:

Perform minimum **six** practical's out of 01 to 10 and all the projects are **mandatory**

Module	Detailed Contents	Lab Sessions/Hr
1	Chain and cross staff surveying.	03 hrs
2	Measuring bearings of a closed traverse with prismatic compass and computation of interior angles.	03 hrs
3	Simple and compound levelling	03 hrs
4	Measurement of horizontal and vertical angles.	03 hrs
5	Finding constants, heights and distances using tachometry.	03 hrs
6	Measurement of distances, bearings and area using total station.	03 hrs
7	Plane Table Surveying by intersection method.	03 hrs
8	Find an area of irregular figure using a conventional planimeter and verify it using a digital planimeter.	03 hrs
9	Setting out a simple curve by Rankine's method.	03 hrs
10	Setting out a simple foundation plan.	03 hrs
Projects		
A survey camp of three days is to be arranged to execute the following projects for undergoing the students through practical instructions in civil engineer's career with the actual field exposure at an ideal site location .		
1	**Project I:** Road project using Auto level for a minimum length of 500 m including fixing of alignment, profile levelling, cross-sectioning at 20m interval,, plotting of 'L' section and 'C' section. (Two full imperial sheets, the first sheet with key plan and 'L' section and the second sheet covering any three typical Cross-sections)	
2	**Project II:** Block Contouring project using Auto level for minimum 60 m × 60 m area and generating contours by MS Excel. (Take contour interval as 0.2 meter)	
3	**Project III:**Tachometric contouring project on a hilly area with at least two instrument stations about 60 m to 100 m apart and generating contours by taking contour intervals as 1 meter.	

Assessment:

Teamwork

Including above practical work, projects and assignments, distribution of marks for Term Work shall be as follows:

Practical Work**-** : 15 marks
Assignments - : 05 marks
Attendance- : 05 marks
Projects-
Field work : 15marks
Office work (Drawings) : 10marks
Total : 50marks

- **End Semester Practical/ Oral Examination**

Practical Examination : 10 Marks

Oral Examination : 15 Marks.

Oral examination will be conducted after conduction of practical examination & it will be based on term work & Practical examination

Reference Books:

1) Surveying and Levelling *: R. Agor, Vol-I, 11th Edition*, Khanna Publishers (ISBN 8174092358)
2) Surveying and Levelling :*Kanetkar and Kulkarni,*Vol-I, 24th Edition, Pune VidyarthiGriha, Pune. (ISBN 8185825114)
3) Surveying and Levelling : *Dr. B.C. Punmia,* Vol.-I, 16th Edition, Vol -II 4th Edition, Laxmi Publications (ISBN9788170088530)
4) Surveying and Levelling: *N NBasak*, 2nd Edition, Tata McGraw Hill, New Delhi. (ISBN 9789332901537)
5) Surveying: Vol-I: Dr K.R. Arora, Standard Book House.
6) Surveying and Levelling (2nd Edition): R. Subramanian; Oxford Higher Education.
7) Surveying and Levelling (Vol.-I): S.K. Duggal, Tata Mc-Graw Hill

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Semester- IV

Course Code	Course Name	Credits
CEL 403	Building Materials & Concrete Technology (Lab)	01

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

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

Objectives:

1) To determine physical and mechanical properties of materials used in the manufacturing of concrete like cement and aggregates.
2) To test the physical attributes and mechanical strength of burnt clay bricks used in the construction of structures.
3) To determine the various properties of fresh and hardened concrete with and without the addition of admixtures.
4) To study the different basic non-destructive tests conducted in the laboratory or on site to determine the durability and strength of existing concrete structures.
5) To utilize the knowledge of mix design in the manufacturing of concrete, in the laboratory.
6) To test the physical attributes and mechanical strength of timber and tiles used in the construction of various components of the structure.
7) To understand the practical scenario of the commonly used building materials in terms of their availability, cost and significance through market surveys.

Outcomes: Learner will be able to…

1) Develop collaborative skills to work in a team/group
2) Test physical properties of cement, aggregates and concrete.
3) Test various other building materials like tiles, bricks and timber
4) Evaluate the effects of admixtures on physical properties of concrete.
5) Design the concrete mix.
6) To bridge the gap between theoretical and market/industrial practices by market surveys.

List of Experiments (first seven are compulsory)

Module	Detailed Contents	Lab Sessions/Hr
1	Physical properties of OPC: Physical test, Fineness, Standard consistency, Soundness, Setting time, Compressive strength.	**02/04**
2	Physical Properties of Fine and Course Aggregates: Specific gravity, bulk density, Moisture content, Water absorption, flakiness index, elongation index, Fineness modulus, Silt content and bulking of sand	**02/04**
3	Tests on burnt clay bricks	**01/02**
4	Effect of w/c ratio on workability (slump cone, compaction factor, V-B test, flow table) and strength of concrete	**02/04**
5	Study of admixtures and their effect on workability and strength of concrete.	**01/02**
6	Non-destructive testing of concrete: Rebound hammer and ultrasonic pulse velocity	**01/02**
7	Concrete mix design in the laboratory	**01/02**
8	Test on tiles(optional)	**01/02**
9	Compression test on timber (Parallel/ perpendicular to the grains). (optional)	**01/02**
10	Market survey on common building materials (optional)	**01/02**

Site Visit/ Industrial Visit:

The students shall visit the brick, paver blocks, concrete block, cement, glass and RMC industrial plants. They shall prepare a report of the visit and the same shall be evaluated by the concerned teacher.

Assessment:

The term work shall consist of:

- Report of experiments performed.
- Industrial visit report to at least **any one** of the above mentioned industrial plants.
- Although minimum numbers of market surveys and industrial visits are prescribed, the students shall be encouraged to perform more number of experiments and site/ industrial visits.

Distribution of the Term Work Marks:

The marks of the term work shall be judiciously awarded for the various components of the term work and depending upon the quality of the term work including industrial/ site visit report. The final certification and acceptance of term work warrants the satisfactory performance of laboratory work by the student, appropriate completion of the assignments. Broadly, the split of the marks for term work shall be as given below. However, there can be further bifurcation in the marks under any of the heads to account for any sub-head therein.

Individual Practical performance **:** 07 Marks

Assignments : 03 Marks

Reports of experiment **:** 05 Marks

Site Visit/Industrial visit	:	05 Marks
Attendance	:	05 Marks
Total	:	**25 marks**

Further, while giving weightage of marks on the attendance, following guidelines shall be resorted tom75% - 80%: 03 Marks; 81% - 90%: 04 Marks; 91% onwards: 05 Marks.

End Semester Practical/Oral Examination

The oral examination shall be based on the entire syllabus and term work comprising of the report of the experiments/ practical conducted by the students and a detail report of the industrial/ site visit.

Recommended Books:

1) A Building Construction: S.*C. Rangwala,* Charotar Publications, Gujarat, India.
2) Building Construction: S.P. Arora, Dr.S.P. Bindra,DhanpatRai Publication, New Delhi.
3) Building Construction: Dr. B.C. Punmia, A.K.Jain, A.R.Jain,Laxmi Publication., New Delhi.
4) Concrete Technology Theory and Practice: M.S. Shetty, S.Chand Publication.
5) Concrete Technology: M.L. Gambhir, Tata McGraw Hill, NewDelhi.
6) Concrete Technology: A.M. Neville & J. J. Brooks., ELBS-Longman.
7) Concrete Technology: A.M. Neville & Isaac Pitman, London.
8) Concrete Technology: A. R. Shanthakumar, Oxford University Press.
9) Materials of Construction: D. N. Ghose, Tata McGraw Hill, Delhi.
10) Building Materials: S.K. Duggal, New Age International Publishers.
11) Concrete Technology: D. F. Orchardi, Wiley, 1962.
12) Relevant codes: BIS, ACI & BS.

Reference Books/Reference Materials:

1) Engineering Materials: *S.R. Rangwala,*Charotar Publications.
2) Architectural Materials science: D. Anapetor, Mir Publishers.
3) Introduction to Engineering Materials: B. K. Agrawal, Tata McGraw Hill, NewDelhi.
4) Engineering Materials: P. Surendra Singh,Vani Education Books, New Delhi.
5) Building Materials (Products, Properties and Systems): M.L. Gambhir and NehaJamwal, McGraw Hill Publications.
6) Properties of concrete: Neville, Isaac Pitman, London.
7) NPTEL Lecture series on Building Materials and Concrete Technology.

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Semester- IV

Course Code	Course Name	Credits
CEL404	Fluid Mechanics – II (Lab)	01

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

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

Course Objectives:

The students will be able to learn:

1) to verify the basic fluid mechanics concepts experimentally
2) the fluid flow pattern in pipes
3) to estimate the losses in pipe flow
4) the velocity distribution in pipes

Course Outcomes:

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

1) Verify the Reynold's experiment
2) Estimate the viscosity of fluid
3) Calculate the losses in pipes
4) Assess the flow pattern and velocity distribution in pipe flow
5) learn the water hammer phenomenon through demonstration
6) learn the wind tunnel testing through demonstration

List of Experiments (Minimum Six)

Module	Detailed Contents	Lab Sessions/Hr
1	Study of different types of flow using Reynold's apparatus	02 hrs
2	Determination of viscosity of fluid	02 hrs
3	Estimation of the head loss due to friction incurred by a fluid along a pipeline (To find the friction factor for the given pipes of different sizes)	04 hrs
4	To determine different losses in pipe fittings (Estimation of the minor losses)	04 hrs
5	Laminar flow through pipes	02 hrs
6	Velocity distribution in circular pipes	04 hrs
7	Turbulent flow through pipe	02 hrs
8	Study of Water Hammer phenomenon	04 hrs
9	Study of wind tunnel	02 hrs

Assessment:

- **Term Work**

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

Laboratory work-	:	15 Marks
Assignments-	:	05 Marks
Attendance	:	05 Marks

- **End Semester Oral Examination**

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Reference Books:

1) Fluid Mechanics and Hydraulic Machines: R. K. Rajput, S. Chand and Company
2) Hydraulics and Fluid mechanics: Dr. P.M. Modi and Dr. S.M. Seth, Standard Book House, Delhi
3) Hydraulics Fluid Mechanics and Fluid Machines: S. Ramamrutham, DhanpatRai Publishing Company (P) Ltd-New Delhi
4) Theory and Application of Fluid Mechanics: K. Subramanian, Tata McGraw hill publishing company, New Delhi.
5) Fluid Mechanics and Hydraulics: Dr. S.K. Ukarande, Ane's Books Pvt. Ltd. (Revised Edition 2012), ISBN 97893 8116 2538
6) Fluid Mechanics and fluid pressure engineering: Dr. D.S. Kumar, F.K. Kataria and sons
7) Fluid Mechanics: R.K. Bansal Laxmi Publications (P) Ltd.

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Semester- IV

Course Code	Course Name	Credits
CEL405	Skill Based Lab Course-II Total Station and Geographical Information System	1

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

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

Objectives:

1) To enable the learners, operate the Total Station and generate its output in terms of plans, elevations and 3D views
2) To enable the learners, operate the Global Navigation Satellite System (GNSS) receivers and retrieve the information
3) To enable the learners work on a Geographical Information System (GIS) platform for assimilating geographical data

Outcomes: Learner will be able to…

1) Operate a Total Station and traverse the field
2) Perform various operations like computing height of a structure, computing area of plot, subdividing area, demarcating boundaries, etc. Using Total Station
3) Set out foundation plan using Total Station
4) Compute the point, line and area features using Global Navigation Satellite System
5) Plot various existing features in a geographic area on a GIS platform
6) Add attribute and perform various statistical operations in GIS

List of Experiments (Minimum Eight)

Module	Detailed Contents	Lab Sessions/Hr
1	Introduction to concepts, fundamental features and working principal of Total Station (TS)	02
2	Temporary settings of a TS in field and perform basic functions on	02

	total station like traversing, area of open plot, height calculations, etc.	
3	Collect detailed features of a plot (comprising features such as 2-3 buildings, courtyards, security cabins, playgrounds, trees, gates, poles, roads, drainage lines, etc.) using TS	04
4	Transfer data collected through TS on a convenient computer aided drafting (CAD) software	02
5	Feeding a CAD plan in TS and setting out a foundation plan using TS	02
6	Introduction to fundamental features of Global Navigation Satellite System (GNSS) and collect point, line and polygon features through a GNSS receiver	02
7	Computing latitudes, longitudes, altitudes of points, length of roads, area of plots, etc. using a GNSS system	02
8	Basic introduction to compatibilities, utilities and attributes of peculiar Geographical Information System (GIS) softwares available in market w.r.t their various commands, features, capabilities and functions.	02
9	Collecting ground points through GNSS and TS for integrating it with spatial data obtained from a GIS platform like google earth, openstreetnetwork, etc. and developing a model on a GIS software	04
10	Add various layers in term of attributes and perform various statistical operations and queries in GIS	04

Assessment:

- **Term Work**

Including Laboratory Work comprising of minimum 8 software generated sheets distribution of marks for Term Work shall be as follows:

Laboratory work : 40 Marks (comprising of min 8 software generated sheets: 4 using TS and GNSS data in CADD tool and 4 using GIS tool)

Attendance : 10 Marks

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Semester- IV

Course Code	Course Name	Credits
CEM 401	Mini Project -1B	1.5

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

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

Objectives

1) To acquaint with the process of identifying the needs and converting it into the problem.
2) To familiarize the process of solving the problem in a group.
3) To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4) To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

1) Identify problems based on societal /research needs.
2) Apply Knowledge and skill to solve societal problems in a group.
3) Develop interpersonal skills to work as member of a group or leader.
4) Draw the proper inferences from available results through theoretical/ experimental/simulations.
5) Analyse the impact of solutions in societal and environmental context for sustainable development.
6) Use standard norms of engineering practices
7) Excel in written and oral communication.
8) Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9) Demonstrate project management principles during project work.

Guidelines for Mini Project

1) Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
2) Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
3) Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
4) A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

5) Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
6) Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
7) Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
8) The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
9) With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
10) However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
  - Marks awarded by guide/supervisor based on log book : 10
  - Marks awarded by review committee : 10
  - Quality of Project report : 05
  -

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

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
- First shall be for finalisation of problem
- Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
- First review is based on readiness of building working prototype to be conducted.

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

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1) Quality of survey/ need identification
2) Clarity of Problem definition based on need.
3) Innovativeness in solutions
4) Feasibility of proposed problem solutions and selection of best solution
5) Cost effectiveness
6) Societal impact
7) Innovativeness
8) Cost effectiveness and Societal impact
9) Full functioning of working model as per stated requirements
10) Effective use of skill sets
11) Effective use of standard engineering norms
12) Contribution of an individual's as member or leader
13) Clarity in written and oral communication

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

Guidelines for Assessment of Mini Project Practical/Oral Examination:

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

Mini Project shall be assessed based on following points;

1) Quality of problem and Clarity
2) Innovativeness in solutions
3) Cost effectiveness and Societal impact
4) Full functioning of working model as per stated requirements
5) Effective use of skill sets
6) Effective use of standard engineering norms
7) Contribution of an individual's as member or leader
8) Clarity in written and oral communication

****

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
Faculty of Science and Technology,
University of Mumbai, Mumbai

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

Preamble

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

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

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

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

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

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

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

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

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

Preface

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

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

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

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

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

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

Undergraduate Program Structure for 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	-	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	-	-	-	-	-	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

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 ofReinforced Concrete: Jain A. K, Nemchand and Bros., Roorkee

Limit State Design ofReinforced 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	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

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
Faculty of Science and Technology,
University of Mumbai, Mumbai

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

Preamble

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

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

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

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

Dr. S. K. Ukarande

Associate Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Dr Anuradha Muzumdar

Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

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

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

Preface

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

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

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

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

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

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

Undergraduate Program Structure for 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

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

<table>
<tr><th colspan="5">Theory</th><th colspan="3">Term Work/Practical/Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal Assessment</th><th rowspan="2">End Sem Exam</th><th rowspan="2">Duration of End Sem Exam</th><th rowspan="2">Term Work</th><th rowspan="2">Pract.</th><th rowspan="2">Oral</th></tr>
<tr><th>Test-I</th><th>Test-II</th><th>Average</th></tr>
<tr><td>20</td><td>20</td><td>20</td><td>80</td><td>4 Hours</td><td>-</td><td>-</td><td>-</td><td>100</td></tr>
</table>

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 1GB, UK.

2 Deo M C (2013):Waves and Structures, http://www.civil.iitb.ac.in/~mcdeo/waves.html

3 American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Load and Resistance Factor Design, 1st Edition, 1993. (TP690.A642 RP2A-LRFD)

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

Semester-VI

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

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

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

Course Objectives:	
1	To estimate the design loads on steel structures as per IS 875
2	To analyze the member forces by any suitable method.
3	To design the members for axial, flexure and shear forces.
4	To prepare the detailed design report and fabrication drawings by manual or CAD software.

Course Outcomes:	
At the end of the course, learner will be able to:	
1	Calculate dead, live and wind loads on the structure.
2	Analyze the structure by analytical/graphical method.
3	Use steel table for selecting appropriate section.
4	Design the members for various load combinations.
5	Design the bolted and welded connection.
6	Read and Prepare the detailed fabrication drawing and design report.

The Project shall be given to a group of students consisting of not more 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

AC-
Item No.-

UNIVERSITY OF MUMBAI

मुंबई विद्यापीठ

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	:	Final 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: 2022-2023

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

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

Preamble

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

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

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

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

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

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

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

Dr. S. K. Ukarande

Associate Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Dr. Anuradha Muzumdar

Dean
Faculty of Science and Technology,
University of Mumbai, Mumbai

Preface

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

*** Theory class to be conducted for full class**

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

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

Undergraduate Program Structure for Final year Civil Engineering

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

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

Examination Scheme									
Course Code	Course Name	Internal Assessment			End Sem Exam	Exam Duration (Hrs.)	Term Work	Pract /Oral	Total
		Test - I	Test – II	Avg.					
CEC701	Design & Drawing of Reinforced Concrete Structure	20	20	20	80	04	-	-	100
CEC702	Quantity Survey, Estimation and Valuation	20	20	20	80	04	-	-	100
CEDLO701 X	Department Level Optional Course – 3	20	20	20	80	03	-	-	100
CEDLO702 X	Department Level Optional Course – 4	20	20	20	80	03	-	-	100
CEILO701 X	Institute Level Optional Course – I	20	20	20	80	03	-	-	100
CEL701	Design & Drawing of Reinforced Concrete Structure	-	-	-	-	-	25	25	50
CEL702	Quantity Survey, Estimation and Valuation	-	-	-	-	-	25	25	50
CEP701	Major Project-Part I	-	-	-	-	-	25	25	50
Total		**100**			**400**	**-**	**75**	**75**	**650**

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

Undergraduate Program Structure for Final year Civil Engineering

University of Mumbai

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

Semester - VII

Department Level Optional Course – 3

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

Department Level Optional Course – 4

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

Institute Level Optional Course – I

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

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

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

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

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

Undergraduate Program Structure for Final year Civil Engineering
University of Mumbai
(With Effect from A.Y. **2022-2023**)
Semester VIII
Department Level Optional Course – 5

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

Department Level Optional Course – 6

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

Institute Level Optional Course – II

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

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

Semester VII

Semester VII

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

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

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

Rationale

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

Objectives

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

7. To introduce concept of Pre-stressed Concrete.

Detailed Syllabus

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

Contribution to Outcome

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

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

Internal Assessment 20 Marks

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

End Semester Examination 80 Marks

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

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

Recommended Books:

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

9. Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.
10. Earthquake resistant design of structures: Pankaj Agarwal, Manish Shrikhande, PHI, New Delhi.

Reference Books:

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

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus			
Module	**Sub-Modules/ Contents**		**Hrs.**
I.	**Introduction**		**03**
	1.1	Importance of Course	
	1.2	Measurement systems for specific items of civil engineering structures	
	1.3	Units of measurement of various items of works	
	1.4	IS1200: - Introduction, deduction rules for Masonry & Plastering work	
II.	**Specifications & Rate Analysis**		**06**
	2.1	Types & importance of specifications, rules to be followed for drafting the specifications of important items of work etc.	
	2.2	Rate analysis, its importance & necessity, Factors affecting rate analysis, Task work, sources of materials, Study of IS 7272 regarding labor output, District Schedule of Rates (DSR) Rate analysis of important items of construction works.	
III.	**Estimates**		**12**
	3.1	**Approximate Estimate** Definition & Purposes of approximate estimates, Methods for preparing approximate estimates & numerical based on methods, Various terms such as administrative approval, technical sanction, Contingencies, Work charged establishments etc.	
	3.2	**Detailed Estimate** Definition & purposes of detailed estimate, Data required for preparation of detailed estimate. Introduction of detailed estimate of load bearing structure. Methods of taking out quantities such as long wall & short wall method, Centre line method for R.C.C. framed structure, Bar Bending Schedule & its necessity, preparation of bar bending schedule of various structuralelements as per code IS2502.	
IV.	**Estimation of Earthwork for Roads & Canals**		**04**
	4.1	Methods of computation of volume of earthwork such as mean area method, mid-sectional area method, Prismoidal formula, Trapezoidal formula etc. & numerical based on methods. Introduction of Mass Haul diagram, Terms like lead & lift etc.	
V.	**Tenders & Contracts**		**06**
	5.1	**Tenders** Definition & types of tenders, Tender notice & its inclusions, Pre-qualification of contractors, Pre-bid meeting, Procedure for submission & opening of tender, acceptance & rejection of tender, Tender validity period, E-Tendering	
	5.2	**Contracts** Definition, basic forms such as Valid, void & voidable contract. General types of contracts with their suitability, conditions of contract	

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

Contribution to Outcomes

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

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

Internal Assessment **20 Marks**

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

End Semester Examination: **80 Marks**

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

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

4) The students will have to attempt any **three** questions out of remaining five questions. Total **four** questions need to be attempted.

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

Recommended Books:

1) Estimating, Costing, Specifications and Valuation: *Chakraborty, M.,* Kolkata.

2) Building and Engineering Contracts: *Patil*, *B. S.,* University Press, Hyderabad.

3) Estimating and costing: *Datta*, *B. N.,* UBS Publications

4) Relevant Indian Standard Specifications, BIS Publications

5) Professional Practice: Dr. Roshan H. Namavati

6) World Bank approved contract documents

Semester VII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

Module	Course Module / Contents		Periods
I	**Introduction of Pre-stressed Concrete**		02
	1.1	Basic concept and general principle	
	1.2	Materials used and their properties, need of high strength concrete and steel	
	1.3	Techniques and systems of prestressing	
	1.4	Advantages of Prestressed Concrete	
II	**Analysis of Pre-stressed Concrete Beams**		10
	2.1	Loading stages, permissible stresses in concrete in compression and tension at transfer and service stages as per limit state of serviceability, maximum compression and limit state of serviceability cracking, permissible stresses in steel, stress method of analysis	
	2.2	Load balancing method of analysis, cable profile	
	2.3	Kern points, pressure line, efficiency of section, internal resisting couple method of analysis,	
III	**Losses in Prestress**		06
	3.1	Loss of stresses in steel due to elastic deformation of concrete, creep in concrete, shrinkage in concrete, relaxation in steel, anchorage slip and friction	
IV	**Analysis of Pre-stressed Concrete Beams in Limit State of Serviceability Deflection**		04
	4.1	Deflection at transfer, short time and longtime deflection of uncracked beams, permissible limits	
V	**Analysis and Design of Pre-stressed Concrete Beams in Limit State of Collapse**		10
	5.1	Shear - Principal tension, permissible limit, analysis and design of beams in shear (sections uncracked in flexure)	
	5.2	Flexure - General philosophy of design, assumptions, analysis and design of beams in flexure	
VI	**Design of Pre-stressed Concrete Beams in Limit State of Serviceability, Maximum Compression and Cracking**		07
	6.1	Suitability of section modulus	
	6.2	Optimum pre-stressing force and corresponding eccentricity	
	6.3	Safe cable zone	

Contribution to Outcome

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

1. Explain the concept of pre-stressing, its casting techniques and applications.
2. Describe difference between RCC and PSC elements and their behavior.

3 Estimate the loss of stresses in pre-stressing steel.

4 Analyze and design the pre-stressed concrete element using relevant IS Code.

Site Visit:

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

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

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

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

4 Only Four questions need to be solved.

Recommended Books/Code:

1 Prestressed Concrete*: N. Krishna Raju*, Tata McGraw-Hill Publishing Company Limited, New Delhi

2 Fundamentals of Prestressed Concrete: *N.C Sinha* and *S.K. Roy*, S. Chand Publishing

3 Prestressed Concrete: *N. Rajagopalan*, Narosa Publishing House

4 Prestressed Concrete Structures: *P. Dayaratnam*, Oxford and IBH Publishing Co. Pvt. Ltd.

5 Prestressed Concrete*: S. Ramamrutham*, Dhanpat Rai Publishing Company Pvt. Ltd, New Delhi

6 IS code: IS:1343-2012

Reference Books:

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

2 Design of Prestressed Concrete: *Arthur H. Nilson*, Wiley

Semester VII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

Module	Sub-Modules/ contents	Periods
	1.1 Introduction: Hydrological cycle, scope of hydrology, water budget equation, data sources.	

I	**1.2 Precipitation:** Measurement of precipitation, network of rain gauges and their adequacy in a catchment, methods of computing average rainfall, hyetograph and mass curve of rainfall, adjustment of missing data, station year method and double mass curve analysis, Depth-Area -Duration relationship, Intensity-Duration - Frequency relationship, Probable Maximum Precipitation.	**8**
II	**2.1 Abstractions from Precipitation:** Evaporation and transpiration, evapo-transpiration, interception, depression storage, infiltration and infiltration indices, determination of water losses. **2.2 Stream Flow Measurement:** Measurement stream-flow by direct and indirect methods, measurement of stage and velocity, area-velocity method, stage-discharge relationships, current meter method, pitot tube method, slope-area method, rating curve method, dilution technique, electro-magnetic method, ultrasonic method.	**6**
III	**3.1 Runoff:** Catchment, watershed and drainage basins, Factors affecting runoff, rainfall-runoff relationship, runoff estimation, droughts	**6**
IV	**4.1 Hydrograph Analysis:** Characteristics, base flow separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, Instantaneous unit hydrograph.	**7**
V	**5.1 Floods:** Estimation, envelope curves, flood frequency studies, probability and stochastic methods, estimation of design flood, flood control methods, Limitations, risk-reliability and safety factor. Flood routing: Hydrologic and hydraulic routings.	**6**
VI	**6.1 Ground Water Hydrology**: Yield, transmissibility, Darcy's law, Dupuitt's theory of unconfined flow, steady flow towards fully penetrating wells (confined and unconfined). Unsteady flow towards wells: Jacob's curve and other methods, use of well Function, pumping tests for aquifer characteristics, methods of recharge.	**6**
	Total	**39**

Contribution to Outcomes

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

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

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended books:

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

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

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

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

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

Rationale

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

Objectives

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

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

Contribution to Outcomes

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

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

Theory Examination:

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

Recommended Books:

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

Semester- VII

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

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

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

Rationale

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

Objectives

The objectives of this course are

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

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

Contribution to Outcome

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

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

Internal Assessment (20 Marks):

Consisting **Two Compulsory Class Tests:**

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

End Semester Examination (80 Marks):

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

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

Recommended Books:

1. Subrata K. Chakrabarti (2005): Handbook of offshore engineering Volume–I & II, Elsevier, The Boulevard Langford Lane, Kidlington, Oxford OX5 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).
5. Brebbia C.A. and Walker, "Dynamic Analysis of offshore structures", Newness butterworth, London, 1978.
6. Sarpakaya T. and Isaacson M., "Mechanics of Wave Forces on Offshore Structures", Van Nostrand Rainhold, NewYork, 1981.

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

Semester VII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcome

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

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

Internal Assessment **20 Marks**

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

Average of marks will be considered for IA.

End Semester Examination **80 Marks**

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

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

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

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

4 Only Four questions need to be solved.

Recommended Books:

1 Roy Chudley and Roger Greeno , Construction Technology , Prentice Hall, 2005.

2 Dr. B.C. Punamia (2008); “Building Construction” Laxmi Publications (P) Ltd.ISBN13: 978-8131804285. 666p.

3 S. S. Bhavekatti (2012); “Building Construction” Vikas Publishing House Pvt Ltd. ISBN-13: 978-9325960794. 356p.

4 Peter. H. Emmons, “Concrete repair and maintenance illustrated”, Galgotia Publications Pvt. Ltd., 2001.

5 S. P. Arora and S. P. Bindra (2010); “Textbook of Building Construction”, Dhanpat Rai & Sons publication, ISBN-13: 978-8189928803. 688p

6 Sushil Kumar (2010); “Building Construction” Standard Publishes-Distributors. ISBN-13: 978-8180141683. 796p.

7 S.C. Rangwala, Building Construction, Charotar Publication Pvt Ltd. Anand

Reference Books:

1 Sankar, S.K. and Saraswati, S., Construction Technology, Oxford University Press, New Delhi, 2008.

2 Peurifoy, Construction Planning, Equipment and methods –-Tata McGraw Hill Publication

3 Mahesh Varma , Construction Equipment Planning and Applications –

4 R. Chudley (revised by R. Greeno), Building Construction Handbook, Addison Wesley, Longman Group, England, 3rd ed.

5 S.S. Ataev, Construction Technology, Mir Publishers, Moscow

6 Robertwade Brown, "Practical foundation engineering hand book", McGraw Hill Publications.

7 Patrick Powers. J., Construction Dewatering: New Methods and Applications, John Wiley & Sons

8 Jerry Irvine, Advanced Construction Techniques, CA Rocketr

Semester VII

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

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

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

Rationale

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

Objectives

1 To give the students hands on experience on various material properties and testing procedures of pavement materials as per IRC standards. To study the soil classification for highway engineering purpose as per different classification system.

2 To understand the concept of stresses in soil. To enable the student to identify the basic deficiencies of various soil deposits and to arrive upon the various ways and means of improving the soil and implementing the techniques of improvement.

3 To understand the requirements of aggregates as per IRC code.

4 To learn bituminous types and mix designs.

5 To understand the different types of distresses in pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements. To study the construction of the concrete roads and low volume roads

6 To learn basic principles of super pave technology of bituminous mixes

Detailed Syllabus

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

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

Contribution to Outcome

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

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

Internal Assessment 20 Marks

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

End Semester Examination 80 Marks

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

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

Recommended Books:

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

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

Reference Books:

1 Principles of Pavement Design, Second Edition, 1975: *Yoder, E.J.,* John Wiley and Sons, Inc., New York.

2 Concrete Roads: *HMSO*, Road Research Laboratory, London.

Semester VII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

Contribution to Outcome

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

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

Internal Assessment 20 marks.

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

End Semester Examination 80 Marks

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

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

Recommended Books:

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

Reference Books:

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

Semester VII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcome

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

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

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

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

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

4 Only Four questions need to be solved.

Recommended Books:

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

Semester VII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcome

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

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

Theory examination:

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

Recommended Books:

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

Reference Books and IS Codes:

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

Semester – VII		
Course Code	**Course Name**	**Credits**
CEDLO7024	**Department Level Optional Course-4: Green Building Constructions**	**03**

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

Theory					Term Work/Practical/Oral			Total
Internal Assessment			End Sem Exam	Duration of End Sem Exam	TW	PR	OR	
Test–I	**Test–II**	**Average**						
20	20	20	80	3 hours	--	--	--	100

Rationale

Globally, buildings are responsible for a huge share of energy, electricity, water and materials consumption. As of 2018, buildings account for 28% of global emissions or 9.7 billion tonnes of CO_2. The United Nations' 2020 global status report and other sources detail that around 35 - 40% of globally generated energy was used by buildings; which also contributed to 33% of worldwide emissions. If new technologies in construction are not adopted during this time of rapid growth, emissions could double by 2050, according to the United Nations Environment Program. Green building construction practices aim to reduce the environmental impact of building as the building sector has the greatest potential to deliver significant cuts in emissions at little or no cost. As civil engineering graduates, it is of utmost importance to have a deep understanding of the concepts and technologies involved in the sustainable development with respect to the construction industry. It is also further desirable for the graduates to have an in-depth knowledge of the green rating systems as well as green auditing & green retrofitting – which will have tremendous scope in the future.

Objectives

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

Detailed Syllabus

Module	Course Modules / Contents		Duration
I	**Introduction**		3
	1.1.	Environmental impact of buildings, concept of sustainable development, concept of green buildings, necessity of green buildings, benefits of green buildings	
	1.2.	Overview of features of green building – design and construction efficiency, water efficiency, energy efficiency, materials efficiency, indoor environmental quality, waste reduction, operations and maintenance	
	1.3.	Examples of green buildings	
II	**Site Selection, Planning and Design**		8
	2.1.	Site preservation	
	2.2.	Passive architecture	
	2.3.	Soil erosion control	
	2.4.	Natural topography and on-site vegetation	
	2.5.	Preservation of transportation of trees on-site	
	2.6.	Heat island reduction	
	2.7.	Optimization in structural design	
	2.8.	Innovation in design process	
III	**Water Conservation and Energy Efficiency**		10
	3.1.	Rainwater harvesting	
	3.2.	Water efficient plumbing fixtures	
	3.3.	Irrigation systems	
	3.4.	Wastewater treatment and reuse	
	3.5.	Water metering	
	3.6.	Wastewater reuse during construction	
	3.7.	Minimum and enhanced energy efficiency	
	3.8.	Commissioning plan for building equipment and systems and post-installation	
	3.9.	On-site and off-site renewable energy	
	3.10	Energy Metering and Management	
IV	**Green building materials and indoor environmental quality**		10
	4.1.	Sustainable building materials	
	4.2.	Use of certified green building materials, products & equipment	
	4.3.	Segregation of waste, organic waste management and handling of waste materials	
	4.4.	Fresh air ventilation	
	4.5.	CO_2 monitoring	
	4.6.	Day lighting	
	4.7.	Minimizing of indoor and outdoor pollutants	
	4.8.	Low-emitting materials	
	4.9.	Occupant well-being facilities	
	4.10	Indoor air quality testing, after construction and before	

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

Contribution to Outcomes

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

Internal Assessment (20 Marks):
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination (80 Marks):
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total six questions, each carrying 20 marks.
2. Question 1 will be compulsory and should cover maximum contents of the curriculum.
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only four questions need to be solved.

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

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

Reference Books/Links:

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

Semester VII

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

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

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

Rationale

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

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcome

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

1 Explain needs of various laws and legislation related to Construction Industry.

2 Describe application of various Contracts and their forms (Documents)

3 Describe application of various Tenders and their forms (Documents)

4 Evaluate needs & Methods of arbitration and dispute resolution mechanism

5 Explain health, safety and labour laws associated with Construction Industry

6 Apply needs of Environmental protection and ethics in Construction Industry

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

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

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

4 Only Four questions need to be solved.

Recommended Books:

1 Manual for Procurement of Works 2019 GoI, Ministry of Finance

2 PWD manual for E-tendering 2018 PWD, India

3 Construction contracts and claims - Simon M.S., McGraw Hill, New York

4 Construction contracts Management- NICMAR Publication India

5 Estimation and contracts B.S. Patil

Reference Books:

1 Construction contracts and claims - Simon M.S., McGraw Hill, New York

2 Construction contracts Management- NICMAR Publication India

Semester VII

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

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

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

Rationale

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

Objectives

1 Students will learn about sustainable development

2 Students will learn different steps within environmental impact assessment

3 Students will learn how to use of EIA for various projects

4 Students will learn the need to assess and evaluate the impact on environment.

5 Students will learn about Environmental Audit

6 Students will learn Major principles of environmental impact assessment

Detailed Syllabus

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

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

Contribution to Outcome

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

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

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

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

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

4 Only Four questions need to be solved.

Recommended Books:

1 Corporate Environmental Management: Welford R, University Press

2 Environmental Assessment: *Jain R K*, Mc-Graw Hill

3 Environmental Impact Assessment: *Harry W Conter*, Mc-Graw Hill

4 Environmental Impact Assessment – Handbook: *John G Rau* and *D C Wooren*, Mc-GrawHill.

5 Introduction to Environmental Impact Assessment, A Chadwick, Taylor & Francis , 2007

6 Environmental Impact Assessment, Barthwal, R. R. New Age International Publications

7 Environmental Impact Assessment, Larry Canter, McGraw-Hill Publications

Reference Books:

1 Strategic Environmental Assessment,R.Therirvel, E. Wilson, S. Hompson, D. Heaney, D.Pritchard, Earthscan, London , 1992

2 A Practical Guide to Environmental Impact Assessment, Paul, A Erickson,Academic Press , 1994

3 Handbook of Environment Impact Assessment by Judith Petts; McGraw Hill publications

4 Environmental Impact Assessment: Theory & Practice, Wathern, P, Publishers-Rutledge, London, 1992.

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

Teaching Scheme

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

Evaluation Scheme

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

Rationale

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

Objectives

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

Detailed Syllabus

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

Contribution to Outcomes

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

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

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

1 Theory Examination:-

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

Internal Assessment **20 Marks**

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

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

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

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

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

Recommended Books:

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

Reference Books:

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

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

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

Contribution to Outcomes:

Students will be able to

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

Assessment:

Internal:

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

End Semester Theory Examination:

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

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

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

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives

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

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

V	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
VI	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Outcomes

Students will be able to…

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

Assessment:
Internal:

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

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

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

Contribution to Outcomes

Students will be able to:

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

Assessment:

Internal:

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

End Semester Theory Examination:

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

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

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

Teaching Scheme

Semester VII		
Course Code	**Course Name**	**Credits**
ILOC7014	**Institute Level Optional Course – I: Design of Experiments**	**03**

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

Evaluation Scheme

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

Objectives:

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

Module	Detailed Contents	Hrs
I	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
II	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
III	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
IV	**Two-Level Fractional Factorial Designs**	07

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

Contribution to Outcomes

Students will be able to

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

Internal Assessment:

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

End Semester Theory Examination:

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

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

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

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

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

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

Evaluation Scheme

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

Objectives:

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

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

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

Outcomes:

Students will be able to

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

Assessment:

Internal:

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

End Semester Theory Examination:

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

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

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

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

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

Outcomes

Students will be able to:

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

Assessment:

Internal:

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

End Semester Theory Examination:

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

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives

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

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

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

Contribution to Outcome

Students will be able to…

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

Assessment:

Internal:

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

End Semester Theory Examination:

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

- Question paper will comprise of total six question carrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

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

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

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

Outcomes:

Students will be able to:

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

Assessment:

Internal:

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

End Semester Theory Examination:

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

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Any 3 out of remaining 5 need to be solved
- Remaining question (Q.2 to Q.6) will be selected from all the modules.

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

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

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

Outcomes: Learner will be able to…

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

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

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

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

Reference

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

Semester-VII

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

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

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

Course Objective:

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

Course Outcomes:

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

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

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

Assessment:

- **Term Work**

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

Distribution of marks for Term Work shall be as follows:

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

- **End Semester Oral and Sketching Examination**

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

Recommended Books:

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

Reference Books:

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

Semester VII

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

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

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

Course Objective:

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

Course Outcomes:

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

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

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

Internal Assessment

Term work: - **25 Marks**

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

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

Distribution of marks for Term Work shall be as follows:

Tutorials: 20 Marks **Attendance: 05 Marks**

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

End Semester Oral Examination: - **25 Marks**

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

Reference Books: -

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

<table>
<tr><th colspan="9">Semester - VII</th></tr>
<tr><th colspan="2">Course Code</th><th colspan="6">Course Name</th><th>Credits</th></tr>
<tr><td colspan="2">CEP701</td><td colspan="6">Major Project Part-I</td><td>03</td></tr>
<tr><th colspan="3">Contact Hours</th><th colspan="6">Credits Assigned</th></tr>
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<tr><th colspan="5">Theory</th><th colspan="3">Term Work/Practical/Oral</th><th rowspan="3">Total</th></tr>
<tr><th colspan="3">Internal Assessment</th><th rowspan="2">End Sem Exam</th><th rowspan="2">Duration of End Sem Exam</th><th rowspan="2">TW</th><th rowspan="2">PR</th><th rowspan="2">OR</th></tr>
<tr><th>Test–I</th><th>Test–II</th><th>Average</th></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>25</td><td>-</td><td>25</td><td>50</td></tr>
</table>

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Guidelines for Project

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

Guidelines for Assessment of Project I

Project I should be assessed based on following points

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

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

Contribution to Outcomes

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

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

Semester-VIII

Semester VIII

Course Code	Course Name	Credits
CEC801	**Construction Management**	**03**

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcome

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

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

Internal Assessment: 20 Marks

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

End Semester Examination: 80 marks

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

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

Recommended Books:

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

Reference Books:

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

Semester VIII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcome

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

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

Site Visit/ Field Visit:

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

Internal Assessment Examination **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

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

IRC Codes:

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

IRS Codes:

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

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

Reference Books:

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

Semester VIII

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

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	--	02	03	--	--	04

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

Rationale

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

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

Detailed Syllabus

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

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

Contribution to Outcome

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

1 Explain the Reservoir planning, storage capacity, Sedimentation & Reservoir losses.

2 Carry out the stability analysis of Gravity & Earth Dam.

3 Explain the causes of failure of various dams & their design criteria.

4 Design an ogee spillway.

5 Suggest suitable energy dissipation measures.

6 Describe the various minor irrigation structures such as Weirs & barrages, Canal Regulators and Cross-drainage works.

Internal Assessment_20 Marks

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

End Semester Examination_80 Marks

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

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

Recommended Books:

1. Irrigation and Water Power Engineering: B.C. Punmia, 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.

Reference Books:

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

Semester VII		
Course Code	**Course Name**	**Credits**
CEDLO8013	**Department Level Optional Course-5: Construction Safety**	**3**

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

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

Rationale

The primary goal of this course is to have students learn that a "culture" of safety needs to be developed within companies for a safety program to be effective. This course is more about managing the safety process than the details involved in the specific construction activities.

Students in this course will be provided an understanding of safe working practices, various training that are required to be undergone by employees to ensure safe working environment on construction sites, record keeping and maintenance of records, compliance with OSHA worker safety, codes and environmental safety laws, inspection procedures, and penalties for lack of conformance to safety laws.

Students will also learn procedures for recognizing hazards, CPR, site safety meetings and accident investigations.

Objectives

1	Plan to comply with safety documentation/procedures and legal requirements
2	Differentiate OSHA requirements for different work activities
3	Design Safety and Emergency response plans
4	Analyse the cost of Accidents
5	Design an effective company safety culture manual
6	Prepare complete corporate safety plan and site-specific safety plan containing hazard analysis of actual construction projects.

Detailed Syllabus

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

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

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

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

Semester VIII

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

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

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

Rationale

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

Objectives

1 To study the different types of pavements depending upon the mode of transportation, factors affecting pavement design, and methods.

2 To understand the concept of analysis of stress, strain and deflection in pavement.

3 To enable the students to understand and analyse the mechanics related to flexible pavements as applicable for highways.

4 To study the various types of structural responses (stresses and deformations) inducing the pavements due to wheel load and other climatic variations. To enable the students to understand and analyses the concrete pavements as applicable for highways.

5 To enable the students to understand and analyse the mechanics related to flexible and concrete pavements as applicable for airports.

6 Evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements and introduce pavement management system

Detailed Syllabus

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

Contribution to Outcome

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

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

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

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

Reference Books:

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

6 The Design and Performance of Road Pavements: *Croney, David et al*, McGraw Hill.

Semester VIII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcome

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

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

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

Internal Assessment: **20 Marks**

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

End Semester Examination: **80 Marks**

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

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

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

3 Remaining questions will be mixed in nature

4 Only Four questions need to be solved.

Recommended Books:

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

Reference Books:

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

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

Course Outcome

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

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

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

Internal Assessment: 20 Marks

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

Theory Examination:-

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

Recommended books:

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

Semester VII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcome

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

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

Internal Assessment: 20 Marks

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

End Semester Examination 80 Marks

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

- Question paper will comprise of **six** questions: each carrying 20marks.
- The **first** question will be **compulsory** which will have the short questions covering the entire syllabus.

- The remaining five questions will be based on all the modules of Entire syllabus. For this, the module shall be divided proportionately further, and the weightage of the marks shall be judiciously awarded in proportion to the importance of the sub- module and contents thereof.
- There can be an internal choice in various sub-questions / questions to accommodate the Questions on all the topics /sub-topics.
- The students will have to attempt any **three** questions out of remaining **five** Questions.
- Total **four** questions need to be attempted.

Recommended Books:

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

Reference Books:

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

Semester VIII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

Contribution to Outcome

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

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

Internal Assessment: 20 Marks

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

End Semester Examination 80 Marks

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

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

Recommended Books:

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

Semester VIII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcome

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

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

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

Recommended Books:

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

Reference Books:

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

Semester - IV

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcome

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

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

Recommended Books:

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

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

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

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

Evaluation Scheme

Theory					Termwork/Practical/ Oral/Tutorials			Total
Internal Assessments			**ESE**	**Durationof ESE**	**TW/TU**	**PR**	**OR**	
IA-I	**IA-II**	**Avg.**						
20	**20**	**20**	**80**	**3 Hr**	**--**	**--**	**--**	**100**

Course Objective

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

Detailed Syllabus

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

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

Contributions to Outcomes

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

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

Theory Examination:

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

Recommended Books:-

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

Semester VIII

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

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

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

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcome

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

1 Apply the principals of hydrological parameters for design of wells.

2 Calculate the specific yield and yield of well under different ground water conditions.

3 Develop a model for groundwater management.

4 Explain the concept of ground water quality models

Internal Assessment **20 Marks**

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

End Semester Examination **80 Marks**

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

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

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

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

4 Only Four questions need to be solved.

Recommended Books:

1 Numerical Ground Water Hydrology: A.K. Rastogi, Penram International Publishing, Mumbai,2007

2 Ground Wter Hydrology: D.K.Todd, John Wiley &Sons, New York, USA, 1980

3 Ground water Hydrology by A. K. Rastogi

4 Hydrology- Principles, Analysis, Design: H.M.Raghunath, New Age International Publishers.

5 Engineering Hydrology: C.S.P.Ojha, R.Berndtsson, &P.Bhunya:, Oxford University Press

Reference Books:

1 Fitts R Charles, "Groundwater Science". Elsevier, Academic Press, 2002.

2 Ramakrishnan, S, Ground Water, K.J. Graph arts, Chennai, 1998

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

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

Outcomes

Students will be able to :

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

Assessment:

Internal:

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

End Semester Theory Examination:

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

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

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

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

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

Outcomes

Students will be able to…

- Describe Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Assessment:

Internal:

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

End Semester Theory Examination:

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

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

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

Outcomes:

Students will be able to…

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

Internal:

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

End Semester Theory Examination:

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

1. Question paper will comprise of total six questioncarrying20 marks
2. Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
3. Remaining question (Q.2 to Q.6) will be selected from all the modules.
4. Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

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

Contribution to Outcomes:

Students will be able to:

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

Assessment:

Internal:

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

End Semester Theory Examination:

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

1. Question paper will comprise of total six questioncarrying20 marks

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

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

Contribution to outcomes

Students will be able to…

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

Assessment:

Internal:

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

End Semester Theory Examination:

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

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

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

Course Outcomes

Students will be able to:

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

Internal:

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

End Semester Theory Examination:

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

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

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

Outcomes:

Students will be able to…

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

Assessment:

Internal:

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

End Semester Theory Examination:

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

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

Reference Books:

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

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

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

Outcomes:

Students will be able to:
- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Assessment:

Internal:

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

End Semester Theory Examination:

In question paper, weightage of each module will be approximately proportional to number of respective lecture hours as mentioned in the syllabus.
- Question paper will comprise of total six question carrying 20 marks
- Question no. 1 is compulsory
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

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

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

Teaching Scheme

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

Evaluation Scheme

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

Objectives:

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

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

Contribution to Outcomes

Students will be able to…

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

<u>Assessment</u>:

Internal:

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

End Semester Theory Examination:

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

- Question paper will comprise of total six questioncarrying20 marks
- Question no. 1 is compulsory. Attempt any 3 from remaining 5 question
- Remaining question (Q.2 to Q.6) will be selected from all the modules.
- Questions may be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) may be from any module other than module 3)

References:

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

Semester-VIII

Course Code	Course Name	Credits
CEL801	Construction Management	01

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

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

Course Objective:

1 To understand the basic functions and construction management.

2 To apply scheduling techniques such as CPM & PERT

3 To gain knowledge of time-cost optimization & effective utilization of resources on construction sites.

4 To gain knowledge of time-cost optimization & effective utilization of resources on construction sites.

5 To know about safety and quality aspect of construction works.

Course Outcomes:

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

1 Summarize & apply the knowledge of management functions like planning, scheduling, Executing & controlling the construction projects.

2 Prepare feasible project schedule by using various scheduling techniques.

3 Gain knowledge of managing various resources & recommend best method of allocating resources to the project.

4 Develop optimum relationship between time & cost for construction project.

5 Implement quality & safety measures on construction sites during execution of Civil Engineering projects.

6 Explain the importance of labour acts.

List of Assignments

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

Term Work

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

Distribution of marks for Term Work shall be as follows:

Assignments: 20 Marks

Attendance : 05 Marks

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

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

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

Reference Books:

1 Construction Engineering and Management: S. Seetharaman.

2 Construction Planning & Management – Dr. U. K. Shrivastava.

3 Construction Project Management: Chitkara K. K. Tata McGraw Hill.

4 Construction Projects planning and Management: P. S. Gahlot and Dhir New Age International (p) Publishers

5 Critical Path Methods in Construction Practice: Antill J M &Woodhead R W, Wiley

6 Construction Hazard and Safety Handbook: King &Hudson, Butterworth

Semester - VIII								
Course Code	**Course Name**							**Credits**
CEP801	**Major Project- Part II**							**06**
Contact Hours			**Credits Assigned**					
Theory	**Practical**	**Tutorial**	**Theory**		**Practical**		**Tutorial**	**Total**
-	12$	-	-		6		-	6
Theory					**Term Work/Practical/Oral**			**Total**
Internal Assessment			**End Sem Exam**	**Duration of End Sem Exam**	**TW**	**PR**	**OR**	
Test–I	**Test–II**	**Average**						
-	-	-	-	-	50	-	100	150

Rationale

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

Objectives

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

Detailed Syllabus

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

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

Contribution to Outcomes

On completion of this course, the students will be able to:

1: Perform on analytical, experimental or numerical method to solve identified problem
2: Produce alternative design solution to meet the functional requirements of the defined problem.
3: Represent the data in Tabular or graphical forms so as to facilitate, analysis & explain of the data.
4: Express Engineering principles & manage the finance required for the execution of the Project.
5: Infer at results, conclusion with its validation, also propose the future scope of work on the identified problem.
6: Communicate effectively their project work by writing reports and publishing technical papers based on entire project work.

Guidelines for Assessment of Project II
Project II should be assessed based on following points
1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. Quality of Written and Oral Presentation

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines. Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai

Students should be motivated to publish a paper in Conferences/students competitions based on the work