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

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Preamble

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

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

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

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

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Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

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Preface

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

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

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

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

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

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

Undergraduate Program Structure for 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

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

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.

Module	Course Module / Contents		Periods
	Detailed Syllabus		
	Working Stress Method:		
1	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.	**06**
	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.	
	Limit State Method:		
2	2.1	Introduction to limit state method of design as per IS:456-2000.	**03**
	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.	
	Limit State of Collapse: Flexure, Shear, Bond and Torsion:		
3	3.1	Design of singly and doubly reinforced Rectangular and Flanged sections for flexure, shear and bond.	**12**
	3.2	Design of beams subjected to bending, shear and torsion.	
	Design of Slabs using Limit state method:		
4	4.1	Design of simply supported one-way slabs as per IS:456-2000.	**04**
	4.2	Design of simply supported two-way slabs as per IS:456-2000.	
	Limit State of Collapse – Compression:		
5	5.1	Limit state of collapse: compression for short and slender column.	**08**
	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.	
	Design of Foundations:		
6	6.1	Design of Isolated square and rectangular footings subjected to axial load and moment.	**06**
	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.

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

Contribution to Outcome

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

1. Describe impact of jet on stationary, moving, hinged and series of plates also solve the numerical based on forces acting on it.

2. Distinguish various types of turbines, Characteristic curves and its components.

3. Analyze Centrifugal pumps by incorporating velocity triangle diagrams.

4. Know the working mechanism of various Hydraulic machines.

5. Identify the hydraulic behaviour of open channel flow and design the most economical section of channels.

6. Explain mathematical relationships for hydraulic jumps, surges, and critical, uniform, and gradually-varying flows.

Internal Assessment   **20 Marks**

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

End Semester Examination   **80 Marks**

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

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

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

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

4. Only four questions need to be solved in total.

Recommended Books:

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

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

3. Fluid Mechanics: Dr. A.K Jain, Khanna Publishers.

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

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

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

7. Flow through open channels, K.G. Ranga Raju. (1993) : New Delhi : Tata McGrawHill, c1993.

8. Flow Through Open Channels. Rajesh Srivastava (2007): Oxford University Press, 2007, pbk, 432 p, ISBN: 0195690385.

Reference Books:

1 Fluid Mechanics: Frank M. White, Tata Mc-Graw Hill International Edition.

2 Fluid Mechanics: Streeter White Bedford, Tata Mc-Graw International Edition.

3 Fluid Mechanics with Engineering Applications: R.L. Daugherty, J.B. Franzini, E.J. Finnemore, Tata Mc-Graw Hill, New Delhi.

4 Hydraulics: James F. Cruise, Vijay P. Singh and Mohsen M. Sherif, CENGAGE Learning India (Pvt.) Ltd.

5 Introduction to Fluid Mechanics: Edward J. Shaughnessy, Jr, Ira M. Katz, James P. Schaffer. Oxford Higher Education.

6 Open channel Hydraulics: Chow, V.T., McGraw Hill International, New York.

7 Open Channel Flow: Henderson F.M., McGraw Hill International, New York.

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

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.

Module	Course Module / Contents		Periods
	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.

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.

Module	Course Module / Contents		Periods
	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).

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	\multicolumn{2}{c	}{**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	\multicolumn{2}{c	}{**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	\multicolumn{2}{c	}{**Repair Process Implementation and Safety During Repairs**}	**06**
	6.1	Legal Documentation and Records: Estimates of repair work, procedure and flow chart for repairs, Bill of quantities, Tendering, Work order, Agreement and Contract, Measurement book, bills, security deposits, role of PMC.(3L)	
	6.2	Safety during Repairs: Causes of accidents, safety signs, barricading, insurance, Temporary Support structures such as, formwork, shuttering, centering, staging and scaffolding.(3L)	
		Total	**39**

Contribution to Outcome

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

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

Internal Assessment   **20 Marks**

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

End Semester Examination   **80 Marks**

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

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

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

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

4 Only four questions need to be solved in total.

Recommended Books:

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

9   Concrete Repair and Maintenance: *Peter H. Emmons and Gajanan M. Sabnis*, Galgotia Publication

10   Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication.
Building Services and Repairs: Dr. A. S. Radke, Tech Knowledge Publications

Reference Books:

1   Guide to Concrete Repair and Protection, HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia

2   CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG (Works), CPWD, Government of India (Nirman Bhawan),
http://www.cpwd.gov.in/handbook.pdf.

3   Guide to Concrete Repair, *Glenn Smoak*, US Department of the Interior Bureau of Reclamation, Technical Service Center, http://books.google.co.in.

4   Management of Deteriorating Concrete Structures: *George Somerville*, Taylor and Francis publication

5   Concrete Building Pathology: *Susan Macdonald*, Blackwell Publishing.

6   Testing of Concrete in Structures: *John H. Bungey*, *Stephen G. Millard and Michael G. Grantham*, Taylor and Francis Publication.

7   Durability of concrete and Cement Composites: *Page, C.L.* and Page*, M.M.,* Woodhead Publishers

8   Fire Safety in Building: V. K. Jain, New Age International Publication, Delhi

9   MEP systems & Repairs of Buildings: A.S. Radke, Published by Synergy Knowledgeware.

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 CO_2 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

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.

Module	Course Module / Contents		Periods
	Detailed Syllabus		
	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.

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.

Module	Course Module / Contents	Periods
	Detailed Syllabus	
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.

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.

Module	Course Module / Contents		Periods
	Detailed Syllabus		
	Urban Transportation Planning		
1	1.1	Problems & factors in Transportation Planning, Development of Transportation Systems in India, Growth of Transport - Trends in Traffic - Imbalances in Transport System.	**04**
	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.	
	Four Stage Modelling		
2	2.1	Trip generation analysis: trip classification, multiple regression analysis, category analysis	**10**
	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.	
	Land Use Transport Modelling		
3	3.1	Urban system components - Urban spatial structure – Accessibility - Location theory.	**05**
	3.2	Land use models - Land use transport models, Lowry & Garin – Lowry models.	
	Transportation Economics		
4	4.1	Economic evaluation of highway schemes, need for economic evaluation, cost and benefits of transportation projects	**10**
	4.2	Basic principles of economic evaluation, Net present value method, benefit/cost ratio method, internal rate of return method. Vehicle operating costs.	
	Urban Public Transport Planning		
5	5.1	Growth history – Urban growth & public transport needs - Modes of public transport and comparison - Public transport travel characteristics	**05**
	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**

| Module | Course Module / Contents | Periods |

	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.

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.

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

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

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

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

Course Objectives:

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

Course Outcomes:

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

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

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

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

Assessment:

- **Term Work**

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

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

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

- **End Semester Oral Examination**

Oral examination will be based on entire syllabus.

- **Recommended books:**

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

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

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

Ultimate Strength Design for Structural Concrete: Arthur, P. D. and Ramakrishnan, V., Wheeler and Co. Pvt. Ltd.
Reinforced Concrete: H.J. Shah, Charotar Publishers, Anand.

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

Illustrated Reinforced Concrete Design: Dr. V. L. Shah and Dr. S. R. Karve, Structure Publications, Pune.
Reinforced Concrete Design: Wang, C. K., Salmon, C. G., and Pincheira, J. A, John Wiley (2007), 7th Edition.
Reinforced Concrete Fundamentals: Ferguson, P. M., Breen, J. E., and Jirsa, J. O., John Wiley & Sons (1988) 5th Edition.

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			
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	Total
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.

Module	Detailed Content	Lab Session / Hr.
**List of Experiments (Minimum Six)**		
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.

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.

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			
Internal Assessment			End Sem Exam	Duration of End Sem Exam	Term Work	Pract.	Oral	Total
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.

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.

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