Semester 3

B.Tech (Civil Engineering) Curriculum – Semester 3

THIRD SEMESTER												Total Marks	
Sl No	Slot	Code	Category	Title	L	T	P	J	S	Hours	Credits	CIA	ESE
1	A	24MAT301	BSC	Probability Distributions and Complex Analysis	3	1	0	0	3	4	4	40	60
2	K	24EST302	ESC	Material Science and Engineering	2	0	0	0	2	2	2	100	
3	B	24CEP303	PCC	Mechanics of Solids	2	1	2	0	4	5	4	60	40
4	C	24CEP304	PCC	Surveying and Geomatics	3	0	2	0	5	5	4	60	40
5	D	24EST305	ESC	Engineering Geology	2	0	2	0	4	4	3	60	40
6	E	24HUT310	HSMC	Life Skills and Professional Ethics	3	0	0	0	3	3	3	40	60
7	S	24CEL307	PCC	Civil Engineering Drawing	0	0	4	0	4	4	2	60	40
8	M/R	24CEM309	MR/RL	MINOR/REMEDIAL	4	0	0	0			4/0	40	60
TOTAL									**25**	**27**	**22**		

Minor in Civil Engineering

24CEM309	BUILDING CONSTRUCTION AND STRUCTURAL SYSTEMS

24MAT301	PROBABILITY DISTRIBUTIONS AND COMPLEX ANALYSIS	L	T	P	J	S	C	Year of Introduction
		3	1	0	0	3	4	2024

Preamble:

This course introduces the concept of discrete, continuous probability distributions, testing of hypothesis, complex differentiation and complex integration. The concepts discussed here are widely used in the modeling and analysis of a wide range of physical phenomena and has got application across all branches of engineering. After completing this course, students will acquire the ability to utilize the above concepts for solving mathematical problems more efficiently.

Prerequisite: A basic course in probability distributions and complex numbers.

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

CO1	Apply the concept and properties of discrete probability distributions in evaluating the required probabilities (Apply Level).
CO2	Analyse suitable random phenomena using the properties and important models of continuous random variables (Apply Level).
CO3	Perform statistical inferences concerning characteristics of a population based on attributes of samples drawn from the population (Apply Level).
CO4	Apply Cauchy- Riemann equations and the concept of harmonic functions for solving problems in various engineering domains (Apply Level).
CO5	Compute different types of contour integrals using Cauchy's residue theorem (Apply Level).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			1				1			1
CO2	3	2			1				1			1
CO3	3	2			1				1			1
CO4	3	2			1				1			1
CO5	3	2			1				1			1

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓

Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-1-0-0	5	15	10	10	40

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: (Discrete probability distributions)

(Text-1: Relevant topics from sections 3.1-3.4, 3.6)

Random variables, Discrete random variables, Cumulative distribution function, Probability mass function, Mean and variance, Discrete probability distributions,

Binomial distribution, Poisson distribution, Mean and variance of Binomial and Poisson distributions.

MODULE II: (Continuous probability distributions)

(Text-1: Relevant topics from sections 4.1-4.4)

Continuous random variables, Cumulative distribution function, Probability density function, Continuous probability distributions, Uniform distribution, Mean and variance of uniform distributions, Normal distribution.

MODULE III: (Test of Hypothesis)

(Text-1: Relevant topics from sections 5.4, 7.2, 8.1, 8.2, 8.3, 9.1, 9.2,9.4)

Population and samples, Sampling distribution of the mean and proportion (for large samples only), Confidence interval for single mean and single proportions (for large samples only). Test of Hypothesis: large sample test for single mean and single proportion, Equality of means, small sample t-tests for single mean of normal population, Equality of means (for independent samples from two normal populations with equal variance)

MODULE IV: (Complex differentiation)

(Text 2: Relevant portions of sections 13.3,13.4)

Circles and disks, half planes, Complex functions, Limit, Continuity and derivatives, Analytic functions, Cauchy-Riemann equations, Laplace equation, Harmonic functions, Harmonic conjugate functions

MODULE V: (Complex Integration)

(Text 2- Relevant topics from sections 14.2,14.3,14.4,15.4,16.1,16.2,16.3)

Cauchy's integral theorem for simply connected domains (without proof), Cauchy's Integral formula for simply connected domains (without proof), Cauchy's Integral formula for derivatives of analytic function, Taylor's series, Maclaurin series and Laurent's series, Poles and Residues, Evaluation of residues, Cauchy's residue theorem.

Text books

1. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, 8th edition, Cengage, 2012
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10thEdition, John Wiley & Sons, 2016.

Reference books

1. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 2012
2. Hossein Pishro-Nik, Introduction to Probability, Statistics and Random Processes, Kappa Research, 2014

3. Sheldon M. Ross, Introduction to probability and statistics for engineers and scientists, 4th edition, Elsevier, 2009.
4. T. Veera Rajan, Probability, Statistics and Random processes, Tata McGraw-Hill, 2008
5. Prof. Pranav Haridas, Complex Analysis, Kerala School of Mathematics, [NPTEL], https://nptel.ac.in/courses/111106141 (Relevant sections)

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. ofHours [45]
	MODULE 1 [9 hours]	
1.1	Discrete random variables and their probability distributions	1
1.2	Discrete random variables and their probability distributions(continued)	1
1.3	Expectation, mean and variance	1
1.4	Binomial distribution-mean and variance	1
1.5	Problems on Binomial distribution	1
1.6	Problems on Binomial distribution (continued)	1
1.7	Poisson distribution- Poisson approximation to binomial	1
1.8	Poisson distribution- mean and variance	1
1.9	Problems on Poisson distribution	1
	MODULE II [9 hours]	
2.1	Continuous random variables and their probability distributions	1
2.2	Continuous random variables and their probability distributions(continued)	1
2.3	Expectation, mean and variance	1
2.4	Expectation, mean and variance(continued)	1
2.5	Uniform distribution – derivation of mean and variance	1
2.6	Problems on Uniform distribution	1
2.7	Normal distribution	1
2.8	Problems on Normal distribution	1
2.9	Problems on Normal distribution (continued)	1
	MODULE III [9 hours]	

3.1	Population and samples, Sampling distribution of the mean and proportion (for large samples only)	1
3.2	Confidence interval for single mean	1
3.3	Confidence interval for single proportion	1
3.4	Test of Hypotheses: Large sample test for single mean	1
3.5	Large sample test for single proportion	1
3.6	Large sample test for equality of means	1
3.7	Small sample tests for single mean of normal population	1
3.8	Small sample t-tests for equality of means	1
3.9	Small sample t-tests for equality of means (continued)	1
	MODULE IV [9 hours]	
4.1	Complex function, limit	1
4.2	Continuity of complex functions	1
4.3	Derivatives of complex functions	1
4.4	Analytic functions	1
4.5	Cauchy-Riemann equations	1
4.6	Cauchy-Riemann equations(continued)	1
4.7	Harmonic functions	1
4.8	Finding harmonic conjugate	1
4.9	Finding harmonic conjugate(continued)	1
	MODULE V [9 hours]	
5.1	Cauchy's integral theorem (without proof) on simply connected domain	1
5.2	Cauchy's Integral formula (without proof)	1
5.3	Cauchy's Integral formula for derivatives of analytic functions	1
5.4	Taylor's series and Maclaurin series	1

5.5	Laurent series	1
5.6	Poles and Residues	1
5.7	Evaluation of residues	1
5.8	Evaluation of residues (continued)	1
5.9	Cauchy's residue theorem	1

CO Assessment Questions	
CO1	1. A certain hospital usually admits 50 patients per day. On the average 3 patients in 100 require special facilities found in special rooms. On the morning of a certain day it is found that there are three such rooms available. Assuming that 50 patients will be admitted find the probability that more than 3 patients will require such special rooms. 2. Using CAS, determine the probability of rolling a sum of 7 or 11 when rolling two fair six-sided dice? Calculate the mean and variance of the probability distribution, generate random samples, and visualize the probability mass function (PMF). 3. **Team Work:** Determine the probability of obtaining at least two heads when tossing a fair coin three times. Once the team has solved this problem, explore variations such as the probability of obtaining at least two heads when tossing the coin four times, or when using a biased coin with a 70% chance of heads and a 30% chance of tails. Explore these variations as a team and discuss the changes in probabilities
CO2	1. A manufacturer knows from experience that the resistance of resistors he produces is normal with mean $\mu = 150\Omega$ and standard deviation $\sigma = 5\Omega$. What percentage of the resistors will have resistance between 148 Ω and 152Ω? Between 140 Ω and 160Ω? 2. A spinner selects a number X randomly from the interval $[0,2\pi)$. The probability of selecting any number between 0 and x is proportional to the length of the interval $[0, x]$. Find the density function of X. What is the probability that the spinner selects a number between 2 and 3? Verify the answer using CAS. 3. **Team Work:** Calculate the probability that a normally distributed random variable with a mean of 75 and a standard deviation of 10 falls between 70 and 80? Additionally, generate random samples from this distribution and visualize the probability density function

	(PDF) using CAS.
CO3	1. A manufacturer of nickel-hydrogen batteries randomly selects 100 nickel plates for test cells, cycles them a specified number of times, and determines that 14 of the plates have blistered. Does this provide compelling evidence for concluding that more than 10% of all plates blister under such circumstances? State and test the approximate hypothesis using a significance level of 0.05. 2. The mean produce of a sample of 100 fields is 200 lbs per acre with standard deviation of 10 lbs. Another sample of 150 fields gives the mean of 220 lbs with a standard deviation 12 lbs. Can the two samples be considered to have been take from the same population whose standard deviation is 11 lbs? Use 5% level of significance. Solve the problem using CAS and verify your answer. 3. **Team Work:** Using CAS, perform a hypothesis test to determine if there is a significant difference in the mean blood pressure between a control group and a treatment group. The datasets 'group1' and 'group2' represent the blood pressure measurements of the respective groups. Assume that the data follows a normal distribution and use a significance level of 0.05. Write CAS code to conduct the hypothesis test, calculate the test statistic, p-value, and provide a conclusion regarding the null hypothesis. Collaborate with your team members, execute the code, and interpret the results. Present your findings, discussing the hypothesis testing procedure and any notable observations made during the activity.
CO4	1. You are analyzing the flow of fluid in a river, and you want to understand the behavior of the velocity field. The velocity of the fluid is described by a complex function, where the real part represents the horizontal component and the imaginary part represents the vertical component. Apply the Cauchy-Riemann equations to determine the conditions under which the fluid flow is both irrotational (zero curl) and incompressible (zero divergence). 2. You are analyzing the flow of heat in a two-dimensional object, and the temperature distribution within the object is described by a harmonic function. For a particular case, let's consider a rectangular metal plate where the temperature distribution is given by $T(x,y) = sin(x)cos(y)$, where (x, y) represents the spatial coordinates. Find the harmonic conjugate of the temperature function $T(x,y)$ and determine the streamlines of heat flow based on the harmonic conjugate. Verify the answer using CAS 3. **Team Work:** What are the critical points and equivalent resistances of a resistor with a nonlinear resistance described by the equation $R = a\|z\|^2 + b\|z\| + c$, where 'a', 'b', and 'c' are constants and 'z' is a complex variable representing the voltage across the resistor? Use complex differentiation to analyze the behavior of the resistor and

	find the critical points by differentiating the resistance equation with respect to 'z' and setting it equal to zero. Finally, substitute the critical points back into the resistance equation to determine the corresponding equivalent resistances.
CO5	1. In the study of a particle's motion along a curve, you aim to approximate the position function $x(t) = t^3 - 2t^2 + 3t - 1$ using a Taylor series expansion. Determine the Taylor series expansion of x(t) around t = 2 and use it to approximate the position of the particle at t = 2.2 up to the second-degree term. 2. The Maclaurin series $\frac{z}{e^z-1} = 1 + B_1 z + \frac{B_2}{2!}z^2 + \frac{B_3}{3!}z^3 + \cdots$ defines the Bernoulli numbers B_n. Using undetermined coefficients, show that $B_1 = \frac{-1}{2}, B_2 = \frac{1}{6}, B_3 = 0, B_4 = -\frac{1}{30}, B_5 = 0, B_6 = \frac{1}{42}$. Write a program for computing $B_n$using CAS. 3. **Team Work**: Research and find real-world applications of complex integration using the Cauchy Residue Theorem. Present your findings in a concise report or presentation, highlighting the applications and explaining how the theorem is used in each case.

24EST302	MATERIAL SCIENCE AND ENGINEERING	L	T	P	J	S	C	Year of Introduction
		2	0	0	0	2	2	2024

Preamble:
The objective of the course is to enable the students to become familiar with the basics of material science and the practical applications of various materials used in construction. Throughout the course, the students will be exposed to the fundamentals of structure and mechanical behaviour of materials, properties and applications of conventional construction materials and their modern use. By the end of the course, the students will be equipped with the knowledge and skills to make informed choices regarding building materials, comprehend concrete properties and identify sustainable and smart materials.

Prerequisite: NIL

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

CO1	Review the structure and mechanical behaviour of materials (Understand level)
CO2	Describe the types, properties and uses of various building materials (Remember level)
CO3	Explain the properties, effects and uses of concrete ingredients (Understand level)
CO4	Discuss the properties and testing procedure of fresh and hardened concrete (Understand level)
CO5	Describe the various sustainable materials and smart materials suitable for construction (Remember level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	3						1					1
CO3	3					2	2					1
CO4	3					2						
CO5	3						2					1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	-
Understand	✓	✓	✓	-
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
2-0-0-0	5	35	30	30	**100**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	-	-

End Semester Examination [ESE]: Pattern: There is no ESE for this course.

SYLLABUS

MODULE I: Material science

Bonds – Review of chemical bonds, states of matter, structure of materials, movement of atoms, development of microstructure

Review of mechanical behaviour – Deformation, stress, strain, Hooke's law, stress-strain diagram – Response of materials to stress – Rheology and thermal properties

MODULE II: Construction materials

Conventional construction materials – Types, properties and uses of building materials – stone, bricks, lime, cement and concrete blocks, timber, glass, paints, polymer, bituminous materials

Metals – Cast Iron and Steel, market forms of steel – steel sections and steel reinforcements, Aluminium

Industrial timber products – Properties and uses of veneer, plywood, fibre board, particle board, multi wood, Glulam

Ceramic products — Tiles, earthenware, stoneware

Fibre reinforced plastic (composite)

MODULE III: Concrete materials

Cement – manufacturing process, chemical composition – Tests on cement – IS specifications

Aggregates – Types, sampling and testing

Quality of water for construction (Brief discussion only, permissible limits of chemical constituents not required)

Admixture – Types and uses of mineral and chemical admixture (Brief discussion only)

Fibres – Fibres used in concrete (Brief discussion only)

MODULE IV: Properties of fresh and hardened concrete

Mix proportioning – nominal and design mix – Process of manufacturing concrete –

batching, mixing, transportation, placing, compacting, finishing, curing

Properties of fresh concrete – workability, factors affecting workability – test on workability (slump test) – segregation and bleeding (brief discussion)

Properties of hardened concrete – strength, factors affecting strength – tests for strength of concrete in compression, tension and flexure

MODULE V: Modern construction materials

Sustainable construction materials – bamboo, earthen materials, recycled aggregates, pozzolanas

Smart and Intelligent materials – types, properties and applications of smart and intelligent materials

Miscellaneous materials- Adhesives, sealants, waterproofing materials, thermal and acoustic insulating materials, decorative panels - modern uses of gypsum

Text books

1. J.F. Young, S. Mindess, R.J. Gray and A. Bentur, The Science and Technology of Civil Engineering Materials, Prentice Hall, 1998.
2. P. C. Varghese, Building Materials, Prentice-Hall India, 2005.
3. M. S. Shetty, Concrete Technology, S. Chand & Co., 2006.

Reference books

1. W. D. Callister and D. G. Rethwisch, Materials Science and Engineering: An Introduction, 10th ed., John Wiley & Sons, 2017.
2. V. Raghavan, Materials Science and Engineering, Prentice Hall, 1990.
3. J.M. Illston and P. L. J. Domone, Construction materials: Their nature and behaviour, 3rd ed., Spon Press, 2001.
4. Michel S. Mamlouk and John P. Zaniewski, Materials for Civil and Construction Engineers, Prentice Hall.
5. L. Reed Brantley and Ruth T Brantley, Building Materials Technology, McGraw-Hill Publishers.
6. Neil Jackson and Ravindra K. Dhir, Civil Engineering Materials, Palgrave Foundations.
7. Don A Watson, Construction Materials and Processes, Career Education.
8. Gandhi M. V. and B. S. Thompson, Smart Materials and Structures, Chapmann & Hall, London.
9. P.K. Mehta and P. J. M. Monteiro, Concrete: Microstructure, properties and materials, McGraw Hill, 2006.
10. A.M. Neville, Properties of concrete, Pearson, 2004
11. Ganapathy, C., Modern Construction Materials, Eswar Press, 2015.
12. Deucher, K.N, Korfiatis, G.P and Ezeldin, A.S, Materials for civil and Highway Engineers, Prentice Hall Inc., 1998.
13. Mamlouk, M.S. and Zaniewski, J.P., Materials for Civil and Construction Engineers, Prentice Hall Inc., 1999.
14. Brain Culshaw – Smart Structure and Materials Artech House – Borton. London-1996.
15. Sandy Halliday, Sustainable Construction, Butterworth-Heinemann, 2008.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (24)
MODULE I (6 Hours)		
1.1	Bonds – Review of chemical bonds, states of matter	1
1.2	Structure of materials	1
1.3	Movement of atoms, development of microstructure	1
1.4	Review of mechanical behaviour – Deformation, stress, strain, Hooke's law, stress-strain diagram.	1
1.5	Response of materials to stress	1
1.6	Rheology and thermal properties	1
MODULE II (6 Hours)		
2.1	Conventional construction materials – stones, bricks (types, properties and uses)	1
2.2	Lime, cement and concrete blocks, timber (types, properties and uses)	1
2.3	Glass, paints, polymer (types, properties and uses) - Bituminous materials	1
2.4	Metals – Cast Iron and Steel, market forms of steel – steel sections and steel reinforcements, Aluminium	1
2.5	Industrial timber products – Properties and uses of veneer, plywood, fibre board, particle board, multi wood, Glulam	1
2.6	Ceramic products —Tiles, earthenware, stoneware Fibre reinforced plastic (composite)	1
MODULE III (4 Hours)		
3.1	Cement – manufacturing process, chemical composition	1
3.2	Tests on cement based on IS specifications	1
3.3	Aggregates – types, sampling and testing. Quality of water for construction (Brief discussion only, permissible limits of chemical constituents not required)	1
3.4	Admixture – Types and uses of mineral and chemical admixture, Fibres used in concrete (Brief discussion only)	1
MODULE IV (4 Hours)		
4.1	Mix proportioning – nominal and design mix – Process of manufacturing concrete – batching, mixing, transportation, placing, compacting, finishing, curing	1
4.2	Properties of fresh concrete – workability, factors affecting workability	1
4.3	Test on workability (slump test) – segregation and bleeding (brief discussion)	1

4.4	Properties of hardened concrete – strength, factors affecting strength. Tests for strength of concrete in compression, tension and flexure	1
MODULE V (4 Hours)		
5.1	Sustainable construction materials – bamboo, earthen materials (characteristics, types and uses). Recycled aggregates, pozzolana (characteristics and uses)	1
5.2	Smart and Intelligent Materials – types, properties and applications	1
5.3	Miscellaneous materials - Adhesives, sealants, waterproofing materials	1
5.4	Thermal and acoustic insulating materials, decorative panels - modern uses of gypsum	1

CO Assessment Questions	
CO1	Discuss the important mechanical properties of materials
CO2	Describe the different types of steel sections and steel reinforcements available in market with the help of neat sketches
CO3	Explain the classification of aggregates
CO4	List the various methods for determining workability. Explain in detail any one method used in the field to determine the workability
CO5	Enumerate the applications of various smart and intelligent materials used in construction

24CEP303	MECHANICS OF SOLIDS	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: The course provides the fundamental concepts of mechanics of deformable bodies and helps students to develop their analytical and problem-solving abilities. The course provides students with a fundamental understanding of the behavior of structural members under various loads. Through a combination of theoretical concepts and practical laboratory experiments, students will gain the knowledge and skills necessary to perform stress analysis and determine the strength & elastic properties of structural materials.

Prerequisite: 24EST106 ENGINEERING MECHANICS

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

CO1	Recall the fundamental terms and theorems associated with mechanics of linear elastic deformable bodies. [Remember level]
CO2	Explain the behavior and response of structural members when subjected to different types of external loads. [Understand level]
CO3	Apply the principles of solid mechanics to calculate internal forces, stresses, strains and energy in structural members subjected to axial, lateral and torsional loads. [Apply level]
CO4	Calculate the stresses and strains along any direction, principal stresses and maximum shear stress at a point in a structural member. [Apply level]
CO5	Analyse the given structural member to calculate the safe load or proportion the cross section to carry the load safely. [Apply level]
CO6	Evaluate the mechanical strength and elasticity characteristics of structural materials by conducting appropriate experiments and prepare a test report. [Apply level]

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	2											
CO3	3	3										
CO4	2	1										
CO5	3	3	2									
CO6	3	2	3					3	3	3		3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				

Create				

Assessment Pattern for Lab component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember	✓	✓
Understand	✓	✓
Apply	✓	✓
Analyse		
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Practical [P]**		**Total Marks**
		Assignment	**Test-1**	**Test-2**	**Class work**	**Lab Exam**	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5hrs

End Semester Examination [ESE]: Pattern

PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Members carrying axial load)

Review of statics, Concept of stress and strain- types, Stress- strain relation- Hooke's law, Young's modulus of elasticity.

Stress- strain diagram of mild steel and HYSD bars. Tension test on steel bars – determination of Young's modulus of elasticity, strength and deformation parameters. Factor of safety, working stress. Axially loaded bars with uniform cross section- stress, strain and deformation. Bars of varying cross-sections, tapering bars of circular and rectangular cross-section. (concept only) Determination of axial force in statically indeterminate systems. (number of unknowns restricted to two)
MODULE II (Temperature stress, Lateral strain, Strain Energy)
Temperature effects, temperature stress in composite bars. Shear stress and shear strain, Modulus of rigidity, simple shear, punching shear. Determination of shear strength using double shear test. Lateral strain, Poisson's ratio, volumetric strain. Bulk modulus of elasticity, relationship between elastic constants. Strain energy – concept. Strain energy due to normal stress. Strain energy in bars carrying axial loads. Instantaneous stress in bars due to gradual, sudden and impact loads. (concept only) Strain energy due to shear stress. Toughness, Impact test – Izod and Charpy tests. Hardness – Brinell and Rockwell hardness tests. Stresses in cylinders and spheres due to internal pressure. (concept only)
MODULE III (Shear force and Bending Moment in Beams)
Beams- different types. Types of loading on beams. (Review) Concept of bending moment and shear force. Relationship between intensity of load, shear force and bending moment. Shear force and bending moment diagrams of cantilever beams, simply supported beams and overhanging beams for different types of loads. Point of contraflexure.
MODULE IV (Bending and shear stresses in beams)
Theory of simple bending, assumptions and limitations. Calculation of normal stress in beams, moment of resistance. Bending test on beams - determination of bending stress. Shear stress in beams. Beams of uniform strength. (concept only) Strain energy due to bending- calculation of strain energy in beams. Differential equation for calculating the deflection of beams. (Introduction and demonstration only. Students are not expected to solve deflection problems.) Maxwell's theorem of reciprocal deflection – experimental verification.
MODULE V (Stress at a point, Columns, Torsion)

Stresses on inclined sections for uniaxial and biaxial stress fields.

Principal stresses and principal planes in 2D problems, maximum shear stress.

Strains along principal directions.

Mohr's circle of stress for 2D problems.

Short columns- direct and bending stress. Kern of a section.

Slender columns- Euler's buckling load (derivation only for columns with both ends hinged), slenderness ratio, limitation of Euler's formula.

Rankine's formula. (concept only)

Torsion of circular and hollow circular shafts, Power transmitted by circular shafts and hollow shafts. (simple problems only)

Strain energy due to torsion. (concept only)

Torsion tests on steel rod, Torsion test on wires using torsion pendulum – determination of modulus of rigidity.

Test on close coiled and open coiled springs – determination of modulus of rigidity.

Text books

1. H. J. Shah and S. B. Junnarkar, Mechanics of Structures, Vol - I, Charotar Publishing House.
2. R. K. Bansal, A Text book of Strength of Materials, Laxmi Publications (P) Ltd., New Delhi.
3. B. C. Punmia, Ashok K. Jain, Arun Kumar Jain, Mechanics of Materials, Laxmi Publications (P) Ltd., New Delhi.

Reference books

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall International Series.
2. James M. Gere, S. P. Timoshenko, Mechanics of Materials, CBS Publishers and Distributors, New Delhi.
3. R. C. Hibbeler, Mechanics of Materials (Edn.10), Pearson.
4. S. Ramamrutham and R. Narayanan, Strength of Materials, Dhanpat Rai Publishing Co. (P) Ltd.
5. Rattan, Strength of Materials, McGraw Hill Education India.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (6 Hours)	
1.1	Review of statics- equilibrium conditions, free body diagrams, centroid, moment of inertia. Concept of stress, types of stresses. Concept of strain, types of strains.	1

1.2	Stress-strain relation- Hooke's law, Young's modulus of elasticity. Stress-strain diagram of mild steel- proportional limit, yield point, ultimate stress, fracture. Stress- strain diagram of HYSD bars. Factor of safety, working stress. Axially loaded bars with uniform cross section - calculation of stress, strain and deformation.	1
1.3	Deformation of axially loaded bars with varying cross section. Stepped bars, bars with tapering cross section, Deformation of axially loaded bars with varying axial loads- elongation of bars under self-weight. (concept only)	1
1.4	Tutorial (Problems on stress and deformation)	1
1.5	Statically indeterminate systems- analysis of axially loaded composite bars. (with maximum two materials) Analysis of indeterminate systems with axial load carrying members. (number of unknowns restricted to two)	1
1.6	Tutorial (Problems on analysis of composite bars and indeterminate systems)	1
	MODULE II (6 Hours)	
2.1	Temperature effects. Temperature stress in composite bars. (Concept only) Shear stress and shear strain, Modulus of rigidity, simple shear, punching shear.	1
2.2	Lateral strain, Poisson's ratio, volumetric strain. Volumetric strain of rectangular bar, circular bar and sphere. Volume expressed in terms of strains along three mutually perpendicular directions.	1
2.3	Bulk modulus of elasticity, relationships between elastic constants.	1
2.4	Strain energy- concept. Resilience, modulus of resilience and proof resilience. Strain energy due to normal stress.	1
2.5	Calculation of total strain energy in bars carrying axial loads. Instantaneous stress in bars due to gradual, sudden and impact loads. (Concept only) Strain energy due to shear stress. Stresses in thin cylinders and spheres due to internal pressure.(Concept only)	1
2.6	Tutorial (Problems on lateral strain, volumetric strain and strain	1

	energy)	
MODULE III (6 Hours)		
3.1	Beams- different types. Types of loading on beams (Review). Concept of bending moment and shear force. Shear force and bending moment diagrams. Relationship between load, shear force and bending moment. Demonstration using simple examples.	1
3.2	Shear force and bending moment diagrams of cantilever beams subjected to point load, uniformly distributed and uniformly varying loads.	1
3.3	Tutorial (Problems on SF and BM diagrams of cantilever beams)	1
3.4	Shear force and bending moment diagrams of simply supported beams subjected to point load, uniformly distributed load and uniformly varying load.	1
3.5	Shear force and bending moment diagrams of overhanging beams subjected to point load and uniformly distributed loads. Point of contraflexure.	1
3.6	Tutorial (Problems on SF and BM diagrams simply supported and overhanging beams)	1
MODULE IV (8 Hours)		
4.1	Theory of simple bending – derivation of equation, assumptions and limitations.	1
4.2	Variation of bending stress across the cross section. Maximum bending stress, section modulus, moment of resistance.	1
4.3	Tutorial (Problems involving bending stress)	1
4.4	Shear stress in beams – derivation of equation. Variation of shear stress across the cross section. (Derivation required for rectangular, circular and triangular sections only)	1
4.5	Tutorial (Problems involving shear stress)	1
4.6	Calculation of allowable loads in beams based on bending stress and shear stress criteria. Proportioning beam sections to carry given load without exceeding the allowable bending stress and shear stress. Beams of uniform strength. (Concept only)	1
4.7	Tutorial (Problems on safe load/proportioning the cross section of beams based on bending and shear stress considerations)	1

4.8	Strain energy due to bending - calculation of strain energy in beams. (Cantilever and simply supported beams subjected to point load and uniformly distributed load only) Deflection of beams – Basic differential equation. Calculation of deflection. (demonstration)	1
MODULE V (10 Hours)		
5.1	Stresses on inclined planes for uniaxial and biaxial stress fields. Element subjected to pure shear.	1
5.2	Principal stresses and principal planes in 2D problems, maximum shear stress. Strains along principal directions. Mohr's circle of stress for 2D problems.	1
5.3	Tutorial (Problems on stress analysis)	1
5.4	Short columns – direct and bending stress. Kern of a section. (concept only)	1
5.5	Slender columns – Buckling, Euler's buckling load for columns with pinned ends. Euler's buckling load for columns with different end conditions (no derivation required). Effective length of columns with different end conditions.	1
5.6	Slenderness ratio, limitation of Euler's formula. Rankine's formula. Safe load calculation using Rankine's formula. (demonstration only)	1
5.7	Tutorial (Problems on columns)	1
5.8	Torsion of circular and hollow circular shafts, assumptions, derivation of torsion equation. Variation of stress across the cross section. Polar modulus. Power transmitted by circular shafts and hollow circular shafts.	1
5.9	Proportioning the shafts to transmit a given power based on shear stress and angle of twist considerations. (Simple problems only) Strain energy due to torsion. (Concept only) Close coiled and open coiled springs subjected to axial load – axial deformation and stiffness. (no derivations required)	1
5.10	Tutorial (Problems on torsion)	1

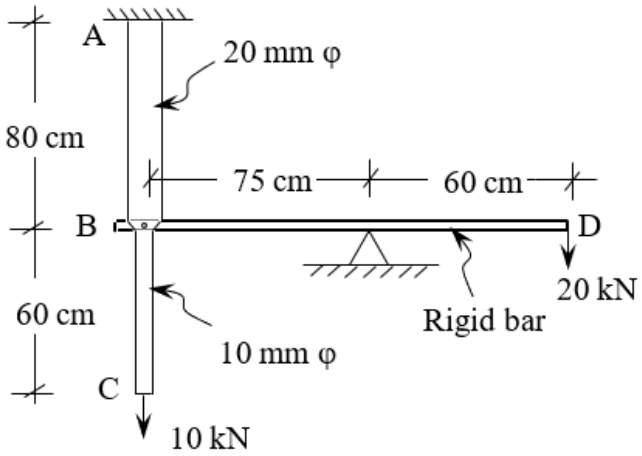
LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Behaviour of members under axial load – determination of strength and elastic properties	2	Tension test on Mild Steel and Tor steel (HYSD) bars (Universal Testing machine and

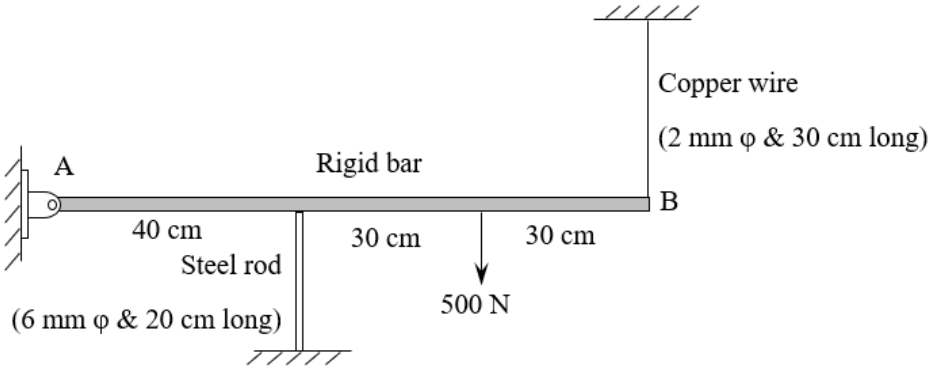
			suitable extensometer)
2	Members subjected to shear – determination of shear strength	2	Shear test on mild steel rod (Compression Testing Machine and Shear Shackle)
3	Members undergoing simple bending – determination of strength and elastic properties	2	Bending test on steel beam (I section) (Universal Testing Machine)
4	Members undergoing simple bending – determination of strength and elastic properties	2	Bending Test on Timber beam (Universal Testing Machine)
5	Deflection of Beams	2	Experimental verification of Maxwell's theorem of reciprocal deflection
6	Rods subjected to torsion – determination of elastic properties	2	Torsion test on Mild steel circular bars (Torsion Testing Machine)
7	Wires subjected to torsion – determination of elastic properties	2	Torsion test on Steel/Copper/ Aluminum wires (Torsion Pendulum)
8	Test on springs - determination of stiffness and elastic properties	2	Test on Springs (a) Open coiled spring (b) Close coiled spring (Spring Testing Machine)
9	Material Properties – Toughness	2	Impact test (a) Izod test (b) Charpy test (Impact Testing Machine)
10	Material Properties – Hardness	2	Hardness test (a) Brinell's Hardness test (Brinell's Hardness Testing Machine) (b) Rockwell Hardness test (Rockwell Hardness Testing Machine)

CO Assessment Questions	
CO1	1. Define proportionality limit and list out its significance. 2. Sketch the stress-strain curve of mild steel and mark the salient points. 3. Describe Poisson's ratio. 4. Define Bulk modulus of Elasticity. Write the relationship between

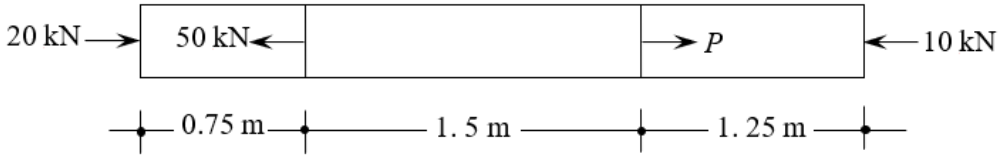
	Bulk modulus of elasticity and Young's modulus of elasticity. 5. Recall pure bending. Give an example. 6. Describe point of contraflexure. 7. List out the limitations of Euler's formula to calculate the buckling load of slender columns. 8. Describe strain energy. 9. Define complementary shear stress. 10. Describe principal stresses and principal planes.
CO2	1. Explain how the deformation of an axially loaded bar with uniformly varying cross section is calculated. 2. Explain the behavior of mild steel under gradually increasing tensile load. 3. Explain the effect of temperature change on a composite bar made of two materials. 4. Explain the procedure for the computation of maximum stress induced in a bar due to impact load. 5. Explain the concept of BM and SF in beams, with the help of a cantilever beam subjected to uniformly distributed load over the whole span. 6. Discuss any three important assumptions used in the theory of pure bending and explain their significance. 7. Explain the behavior of slender columns under axial compressive load. 8. Distinguish between short and long columns with reference to their behavior under axial compression. 9. Explain how the limitation of Euler's formula to calculate buckling load of columns is addressed in Rankine's formula.
CO3	1. A steel flat of cross section 25 mm × 6 mm carries a tensile load of 12 kN. Find the stress induced in the cross section. If a circular hole of diameter 12 mm is made (normal to the flat surface), find the maximum stress induced in the cross section. 2. The bar ABC shown in figure is made of steel and has a circular cross section. The bar BD is rigid. Find the stresses in portions AB and BC and the vertical deflection at C. Take E = 210 GPa.



3. A rigid bar AB of length 100 cm, hinged at one end is supported by a steel rod and a copper wire as shown. Find the stresses induced in the rod and wire due to a downward load acting at 70 cm from the hinged end of the bar. Calculate the vertical deflection at B also. Modulus of elasticity of steel and copper are 200 GPa and 80 GPa respectively. Neglect the weight of the rigid bar.

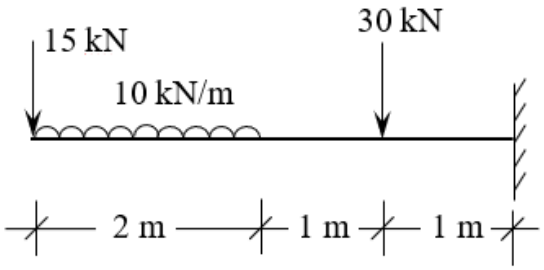
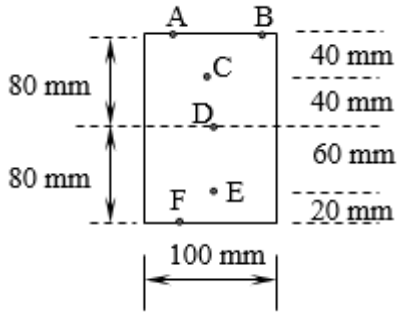


4. A 32 mm diameter steel bar is subjected to forces as shown in figure. Find the value of P necessary for equilibrium and stresses in different segments. Also calculate the final length of the bar. Take E= 200 GPa.



4. A cylindrical bar with two sections of lengths 50 cm and 25 cm, and diameters 20 mm and 15 mm respectively is subjected to an axial pull such that the maximum stress is 150 MN/m^2. Calculate the strain energy stored in the bar. E = 200 GN/m^2.

5. Draw the SFD and BMD of the beam shown.

	 6. Figure shows the cross section of a beam. Find the stresses (both magnitude and nature) at points A, B, C, D, E and F, if the section carries a BM of 12 kNm. Draw the variation of stress across the cross section. Also calculate the shear stress at these points if the cross section carries a SF of 50 kN. 
CO4	1. A bar of 12 mm diameter carries an axial pull of 15 kN. Find the normal and shear stress on a plane inclined at 60° with the axis of the bar. Calculate the maximum shear stress induced in the bar and the inclination of the corresponding plane? 2. At a certain point in a strained material, the stresses on two planes at right angles to each other are 50 MPa (tensile) and 80 MPa (compressive). They are accompanied by a shear stress of magnitude 20 MPa. Find the principal stresses and locate their planes. Also find the maximum shear stress and resultant stress on the plane of maximum shear stress.
CO5	1. A timber beam 150 mm × 200 mm is used as a simply supported beam of span 3 m. Find the maximum uniformly distributed load that can be applied in addition to a concentrated load of 5 kN acting at the mid span, if the maximum bending stress in the beam is not to exceed 8 N/sq. mm . Neglect self weight of the beam. 2. A 3 m long cantilever beam of rectangular section is required to carry a udl of 10 kN/m over the whole span. If the maximum bending stress is limited to 12 N/mm^2, find the dimensions of the cross section assuming depth to width ratio as 2. 3. A cast iron test beam 25 mm square in section and 700 mm long is simply supported at ends. It fails under a central load of 2300 N. Find the load at the free end that will break a cantilever of the same material 50 mm wide × 100 mm deep and 1500 mm long? 4. A solid circular shaft transmits 80 kW power at 190 rpm. Calculate the diameter of the shaft if the twist in the shaft is not to exceed 1° in

	2 m length of shaft and shear stress is limited to 60 MPa. Take G = 100 GPa.
CO6	1. A) Determine the following values for a mild steel specimen a) Stress at which the specimen starts yielding b) Young's Modulus of elasticity B) Determine the resistance of the given specimen against indentation. A graduated microscope can be used during the experiment. 2. A) Determine the toughness of the given specimen when the specimen has to be fixed as a simply supported beam. B) Determine the resistance to shear and resistance to deformation in a compression spring. 3. A) Determine the toughness of the given specimen when the specimen has to be fixed as a vertical cantilever beam. B) Experimentally evaluate the resistance to shear in a mild steel rod. 6. A) Determine the measure of rigidity and resistance to deformation in a tension spring. B) State and prove the Clark Maxwell's law in steel specimen. Evaluate the modulus of elasticity of the specimen.

24CEP304	SURVEYING AND GEOMATICS	L	T	P	J	S	C	Year of Introduction
		3	0	2	0	5	4	2024

Preamble: Objective of the course is to impart an awareness on the principles of surveying, surveying techniques, from linear and angular methods to advanced surveying equipment applications. Imparts practical knowledge in principles of levelling, contouring and the estimation of earth work area and volume. Upholding these principles, students are proficient in utilizing theodolite concepts, mastering traverse surveying methods and embracing modern surveying technology for the betterment of our profession and society.

Prerequisite: Nil

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

CO1	Apply the knowledge of surveying techniques in linear, angular and vertical measurements (Understand and Apply Level)
CO2	Estimate the area and volume of earth work (Apply Level)
CO3	Discuss the method of setting out curves in ground (Understand and Apply Level)
CO4	Apply the different methods of traverse and triangulation survey (Understand and Apply Level)
CO5	Employ surveying techniques using advanced surveying equipment (Understand and Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							3	3	3		
CO2	3											
CO3	3											
CO4	3											
CO5	3				3			3	3	3		

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember		
Understand	✓	✓

Apply	✓	✓
Analyse		
Evaluate		
Create		

Mark Distribution of CIA							
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Practical [P]**		**Total Marks**
		Assignment	**Test 1**	**Test-2**	**Class work**	**Lab Exam**	
3-0-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5 Hours

End Semester Examination [ESE]: Pattern

PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 2	`	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Introduction to Plane Surveying)

Objectives, Principles, classification:-

Linear method - chain surveying (brief description only) Survey stations, Survey lines-ranging. (direct method only)

Angular method – Compass survey-Bearing of survey lines, computation of angle, Local attraction, Dip and Declination.

Practical: Chain and compass surveying (demo)

MODULE II (Levelling, Computation of Area and Volume)
Principles of levelling- Instruments, Temporary adjustment, booking and reducing levels, Methods of levelling- simple, differential, reciprocal levelling, profile levelling and cross sectioning. Contouring: Characteristics, uses and methods. Area and Volume: computation of area by offsets to baseline; volume of level section by prismoidal and trapezoidal formulae. **Practical: Different methods of Spirit Levelling, Contouring using total station**
MODULE III (Theodolite survey and Curve surveying)
Theodolite survey: Instruments, Measurement of horizontal and vertical angle. Curve Surveying –Types of curves, Elements & Setting out of Simple and Compound curve. (Rankines methods only) **Practical: Measurement of horizontal and vertical angle using Theodolite**
MODULE IV (Triangulation & Traverse surveying)
Triangulation: Classification, Triangulation figures, Strength of figure (introduction only), Triangulation stations - Intervisibility of stations, Types of signals, Satellite Stations and reduction to centre. Traverse Surveying - Methods of traversing, Checks in closed traverse, Traverse computations, Balancing the traverse- Bowditch's rule, Transit rule, graphical method based on Bowditch's rule. **Practical: Traversing and area calculation using Total station**
MODULE V (Advanced surveying Techniques)
Introduction to advanced surveying - Total Station – concept of EDM, Types of EDM, Parts of a Total Station – Accessories – Advantages and Applications, Errors in Total Station Survey. Global Positioning Systems-Components, principles, and application of GPS, GPS Surveying methods-Static, Rapid static, Kinematic methods – DGPS. Geographical Information System- Basics, Map projections- methods, components of GIS, GIS operations, Coordinate systems-Geographic and Projected coordinate systems. **Practical: Plot a given area using Total station and hand held GPS.**

Text Books

1. Prof. T.P. Kanetkar & Prof.S.V. Kulkarni - Surveying and Levelling , Pune VidyarthiGriha Prakashan,2004.
2. N N Basak, Surveying and Levelling, McGrawHill Education.
3. Dr. B.C. Punmia, Ashok Kumar Jain &Arun Kumar Jain - Surveying, Laxmi publications (P) Ltd., 2005.
4. R. Agor - A Textbook of Surveying and Levelling, Khanna Publishers, 2005.
5. S.K. Duggal - Surveying Vol. II, Tata McGraw Hill Ltd, Reprint 2015.
6. George Joseph, “Fundamentals of Remote Sensing”, University Press, 2003.

Reference books

1. C. Venkatramaiah, Textbook of Surveying, Universities Press (India) Private Limited 2011.
2. James M Andersen, Edward M Mikhail, Surveying Theory and Practice, McGraw Hill Education.
3. Iliffe, C.J., Datums and Map Projections for Remote Sensing, GIS and Surveying, Whittles Publishing, 2006.
4. James M Andersen, Edward M Mikhail, Surveying Theory and Practice, McGraw Hill education, 7e, 1998.
5. Kang-tsung Chang, „Introduction to GIS" , Tata McGraw-Hill Publishing Co. Ltd, 8e, 2016.
6. Lillesand M and Kiefer W, “Remote Sensing and Image Interpretation”. John Wiley and Sons,Inc., 2000.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE 1(6 Hrs)	
1.1	Introduction to Surveying- Objectives, Principles.	1
1.2	Linear methods - Instruments - chain surveying. (brief description only)	1
1.3	Survey stations, Survey lines- ranging. (direct method only)	1
1.4	Angular method – Compass survey.	1
1.5	Bearing of survey lines- Types of bearing, Designation of bearing- WCB and QB.	1
1.6	Computation of angle, Local attraction, Dip and Declination.	1

MODULE II (9 Hrs)		
2.1	Levelling: Introduction, Principles of levelling- simple, differential.	1
2.2	Instruments, Dumpy level-Booking.	1
2.3	Reduction of levels - methods, problems.	1
2.4	Reciprocal leveling, Profile levelling and cross sectioning.	1
2.5	Contouring: Characteristics, uses. Digital and Auto Level.	1
2.6	Area : computation of area by offsets to baseline.	1
2.7	Volume: computation of area by offsets to baseline.	1
2.8	Volume of level section by prismoidal formula.	1
2.9	Volume of level section by trapezoidal formula.	1
MODULE III (7 Hrs)		
3.1	Theodolite survey: Instruments, Measurement of horizontal and vertical angle.	1
3.2	Curve Surveying –Types of curve, Elements of simple curve.	1
3.3	Relationship between elements of a simple circular curve - problems.	1
3.4	Setting out of a Simple curve. (Rankine's method only)	1
3.5	Setting out of a Simple curve. (Rankine's method only)	1
3.6	Elements & Setting out of Compound curve. (Rankine's method only)	1
3.7	Setting out of a Simple curve. (Rankine's method only)	1
MODULE IV (9Hrs)		
4.1	Triangulation: Classification, Triangulation figure, Strength of figure (Introduction only)	1
4.2	Triangulation stations - Intervisibility of stations.	1
4.3	Triangulation stations - Intervisibility of stations.	1

4.4	Types of signals, Satellite Stations and reduction to centre.	1
4.5	Reduction to centre.	1
4.6	Traverse Surveying -Introduction, open and closed traverse, Methods of traversing, Checks in closed traverse.	1
4.7	Traverse computations: Latitude, Departure, Closing error- problem.	1
4.8	Balancing the traverse- Bowditch's rule, Transit rule.	1
4.9	Graphical method based on Bowditch's rule, Omitted measurements. (a line and an angle only)	1
MODULE V (5 Hrs)		
5.1	Introduction to advanced surveying - Total Station – concept of EDM, Types of EDM. Parts of a Total Station – Accessories – Advantages and Applications, Errors in Total Station Survey.	1
5.2	Global Positioning Systems-Components, principles, and application of GPS.	1
5.3	GPS Surveying methods-Static, Rapid static, Kinematic methods – DGPS.	1
5.4	Geographical Information System- Basics, Map projections-methods, components of GIS, GIS operations.	1
5.5	Coordinate systems-Geographic and Projected coordinate systems.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Levelling - Simple levelling	2	To find the level difference between two points
2	Levelling - Differential and Fly Levelling	2	To find the reduced level between two points
3	Theodolite survey	2	Repetition and Reiteration method
4	Theodolite survey	2	Distance between two accessible points
5	Theodolite survey	2	Distance between two inaccessible points

6	Theodolite survey	2	Level difference between two points using vertical angle measurement
7	Total station survey	2	Introduction Horizontal and vertical distance measurements
8	Total station survey	2	Traversing and area calculation
9	Contour survey	2	Prepare a contour map using total station
10	Survey camp	2	Plot a given area using Total station, distomat and hand held GPS.

CO Assessment Questions	
CO1	1. Explain various survey stations and survey lines in chain surveying. 2. Define contour. What are the characteristics of a contour? 3. Explain the importance of local attraction in compass surveying. How to eliminate the local attraction? 4. Calculate the horizontal distance between two inaccessible points A and B, base line measurements are permitted. (Practical)
CO2	1. A series of offsets were taken at 3m intervals in the following order from a chain line to a curved boundary 2.16, 1.53, 1.80, 1.98, 1.80, 1.59, 1.80, 2.52, 2.43, 2.40, 2.58, 2.70, 2.91 and 3.06 meters. Find the area between the chain line, curved boundary and the end offsets by Simpson's rule and trapezoidal rule.
CO3	1. The chainage at the points of intersection of the tangents to a railway curve is 3876 links and the angles between them is 124 degree. Find the chainage at the beginning and end of the curve if it is 40 chain radius.
CO4	1. Calculate the area of a closed traverse using total station.(Practical) 2. Explain Bowditch's method for balancing a closed traverse.
CO5	1. Define EDM. Explain the different types of EDM instruments? 2. Define map projection. Explain various methods of map projection. 3. Determine the area of the given polygon using Total Station. (Practical)

24EST305	ENGINEERING GEOLOGY	L	T	P	J	S	C	Year of Introduction
		2	0	2	0	4	3	2024

Preamble: This course aims to provide students with a comprehensive understanding of fundamental earth processes, materials, groundwater, and their geological characteristics essential for Civil Engineering applications. By engaging in analytical and practical exercises, students will acquire the skills necessary to recognize, articulate, and proficiently utilize these geological principles. This knowledge will empower them to make informed decisions and tackle challenges effectively in the field of civil engineering construction.

Prerequisite: Nil

Course Outcomes:

	After the completion of the course, the student will be able to
CO1	Recall the fundamental concepts of surface processes, subsurface process, minerals, rocks, groundwater and geological factors in civil engineering constructions (Remember level)
CO2	Identify and describe the surface processes, subsurface process, minerals, rocks, groundwater and geological factors in civil engineering constructions (Understand level)
CO3	Apply the basic concepts of surface processes, subsurface process, minerals, rocks, groundwater and geological factors in civil engineering constructions (Apply level)
CO4	Analyse and classify geological processes, earth materials and groundwater (Analyse level)
CO5	Analyse geological factors in civil engineering constructions (Analyse level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	2	2	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	3	-	-	-
CO4	3	2	-	-	-	-	-	-	3	-	-	-
CO5	3	1	3	-	-	3	3	2	3	-	-	2

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse	✓	✓	✓	✓

Evaluate				
Create				

Assessment Pattern for Lab component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create		

Mark Distribution of CIA							
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Practical [P]**		**Total Marks**
		Assignment	**Test-1**	**Test-2**	**Class work**	**Lab Exam**	
2-0-2-0	5	10	-	15	15	15	60

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Relevance of Engineering Geology)

Relevance of Engineering Geology in civil engineering, Surface Processes of the earth- Weathering of rocks, Origin of Products of weathering like sand, clay, laterite and soil, soil mineralogy, soil profile, Geological logging, weathering grades in rocks, Engineering significance of weathering. Soil erosion and soil conservation measures. Geological processes by rivers, Landslides- Types, causes and Controlling measures. Coastal Processes-Geological work done waves and currents, coastal protection measures.

MODULE II (Internal Processes of Earth)

Internal Processes of the earth-Earthquakes- Plate Tectonics, Origin of earthquakes, Seismic waves, Rating of earthquakes, types of earthquakes, Seismic zones of India. Basics of seismic safety factor, Interior of the earth as revealed by propagation of seismic waves. Geological Mapping and Topographic Maps

Objective: Introduce students to geological mapping techniques.

Practical: Interpretation of geological maps.

MODULE III (Groundwater)

Groundwater-Hydrogeology-Occurrence of groundwater, aquifers and types of aquifers, confining beds, porosity and vertical distribution of groundwater, Permeability/hydraulic conductivity. Problems created by groundwater to civil engineering structures, Methods to control groundwater problems, Electrical resistivity survey for groundwater exploration. Seawater intrusion in Coastal areas.

Practical: Geophysical Methods in Engineering Geology for Groundwater Exploration.

MODULE IV (Earth Materials)

Earth Materials-Mineralogy-Physical properties of minerals, physical properties and chemical composition of minerals like quartz, orthoclase, plagioclase, biotite, muscovite, hornblende, augite, hypersthene, calcite and gypsum, clay minerals. Petrology-Igneous, sedimentary and metamorphic rocks.

Igneous rocks-Chemical and mineralogical classification and structure of igneous rocks. Sedimentary rocks-Types based on mode of formation and sedimentary structures. Metamorphic rocks- Structures only. Megascopic study of rocks like granite, dolerite, basalt, sandstone, limestone, shale, gneiss, marble and charnockite. Rock types of Kerala. Rock mass classification, Rock mass rating, Geological strength index of rocks**.**

Practical: Identification and Classification of Rocks.

MODULE V (Structural Geology)

Structural Geology- Attitude of rocks-dip and strike. Topographic sheet. Structural mapping. Clinometer compass and Brunton compass. Terminology, brief classification and engineering significance of folds, faults and joints. Geological part of site investigation for the construction of dams, reservoirs and tunnels.

Practical: Field Equipment Handling and Surveying Techniques.

Text Books:

1. Duggal S.K, Pandey H.K and Rawat N (2014) Engineering Geology, Mc Graw Hill Education New Delhi.
2. Gokhale KVGK (2015) Principles of Engineering Geology, BS Publications, Hyderabad.
3. Singh P (2014) Engineering and General Geology, SK Kataria and sons, New Delhi.

4. Subinoy Gangopadhyay (2017) Engineering Geology, Oxford University.

Reference Books:

1. David K Todd & Larry W Mays (2011) Groundwater Hydrogeology, Wiley India Pvt Ltd.
2. Gokhale N.W. (2015) Manual of Geological Maps, CBS Publishers, New Delhi.
3. Gribble CD (2005) Rutleys Elements of Mineralogy, Springer.
4. Marland P Billings (2016), Structural Geology, Pearson education.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (24)
Module I (6 Hours)		
1.1	Relevance of Engineering Geology in civil engineering, Surface Processes of the Earth- Weathering of rocks.	1
1.2	Origin of Products of weathering like sand, clay, laterite and soil.	1
1.3	Soil mineralogy, soil profile, Geological logging, weathering grades in rocks, Engineering significance of weathering.	1
1.4	Soil erosion and soil conservation measures.	1
1.5	Geological processes by rivers, Landslides- Types, causes and Controlling measures.	1
1.6	Coastal Processes-Geological work done on waves and currents, coastal protection measures.	1
Module II (4 Hours)		
2.1	Internal Processes of the Earth-Earthquakes- Plate Tectonics, Origin of earthquakes.	1
2.2	Seismic waves, Rating of earthquakes, Types of earthquakes.	1
2.3	Seismic zones of India, Basics of seismic safety factor.	1
2.4	Interior of the earth as revealed by propagation of seismic waves.	1
Module III (5 Hours)		
3.1	Groundwater-Hydrogeology-Occurrence of groundwater.	1
3.2	Aquifers and types of aquifers.	1
3.3	Confining beds, porosity and vertical distribution of groundwater, Permeability/hydraulic conductivity.	1
3.4	Problems created by groundwater to civil engineering structures, Methods to control groundwater problems.	1
3.5	Electrical resistivity survey for groundwater exploration, Seawater intrusion in Coastal areas.	1

Module IV (5 Hours)		
4.1	Earth Materials-Mineralogy-Physical properties of minerals.	1
4.2	Physical properties and chemical composition of minerals like quartz, orthoclase, plagioclase, biotite, muscovite, hornblende, augite, hypersthene, calcite and gypsum, clay minerals.	1
4.3	Petrology-Igneous, sedimentary and metamorphic rocks. Igneous rocks-Chemical and mineralogical classification and structure of igneous rocks.	1
4.4	Sedimentary rocks-Types based on mode of formation and sedimentary structures. Metamorphic rocks- Structures only.	1
4.5	Megascopic study of rocks like granite, dolerite, basalt, sandstone, limestone, shale, gneiss, marble and charnockite. Rock types of Kerala. Rock mass classification, Rock mass rating, Geological strength index of rocks.	1
Module V (4 Hours)		
5.1	Structural Geology- Attitude of rocks-dip and strike. Topographic sheet. Structural mapping. Clinometer compass and Brunton compass.	1
5.2	Terminology, brief classification and engineering significance of folds.	1
5.3	Terminology, brief classification and engineering significance of faults and joints.	1
5.4	Geological part of site investigation for the construction of dams, reservoirs and tunnels.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Interpretation of geological maps (folds, faults, strike, and dip).	2	Plotting geological formations on a topographic map.
		2	Plotting geological formations on a topographic map.
		2	Preparing simple geological maps from given data.
2	Geophysical Methods in Engineering Geology	2	Provide basic knowledge of geophysical survey methods.

		2	Conducting Resistivity tests on soil and rock samples with the assistance of State Groundwater Department.
3	Identification and Classification of Rocks	4	Identification of igneous, sedimentary, and metamorphic rocks using physical properties (color, texture, hardness, etc.).
4	Field Equipment Handling and Surveying Techniques	2	Using a Brunton Compass for geological fieldwork.
		2	Measurement and interpretation of strike and dip using a geological compass.

CO Assessment Questions	
CO1	Describe any chemical reaction in chemical weathering.
CO2	Explain the factors that can be used for assessing the seismic proneness of an area.
CO3	Demonstrate applying the principles of electrical resistivity method to locate the presence of groundwater.
CO4	Relate the types of rocks present in the coastal areas of Kerala to the challenges faced by the construction industry in construction of structures in coastal Kerala.
CO5	Analyze the relevant geological factors to locate the site for the construction of a dam.

24HUT310	LIFE SKILLS AND PROFESSIONAL ETHICS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to enhance the employability and maximize the potential of the students by introducing them to the principles underlying personal and professional success. It equips them with the necessary skills to apply these principles effectively in their lives and careers. This course covers essential life skills for personal and professional success, introduces creative problem-solving techniques, fosters teamwork and leadership qualities, highlights the core values of professional ethics, and explains how individuals play a crucial role in technological development while maintaining personal and legal ethical standards.

Prerequisite: NIL

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

CO1	Describe different life skills required in personal and professional life (Understand Level)
CO2	Illustrate appropriate thinking and problem-solving techniques to solve new problems creatively (Apply Level)
CO3	Demonstrate the basics of teamwork and leadership qualities (Apply Level)
CO4	Identify the core values that shape the ethical behaviour of a professional. (Understand Level)
CO5	Explain the role and responsibility in technological development upholding personal ethics and legal ethics (Understand Level)

CO – PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						✓		✓			✓	✓
CO2		✓	✓	✓				✓	✓		✓	✓
CO3								✓				✓
CO4								✓				✓
CO5						✓		✓				✓

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure[L-T-P-J]	Attendance	Theory [L-T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hrs

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (FOUNDATION OF LIFE SKILLS)

Understanding Life Skills*:* Meaning and Significance of Life Skills-WHO-Identified Life Skills-Life skills for professionals

Self-awareness: Definition and Need-Tools and Techniques of Self-awareness

Stress Management: Stress, reasons and effects- stress diaries- Four A's of stress management

Coping with emotions: Identifying and managing emotions- PATH method and relaxation techniques
(Group activities for self-awareness and stress management)

MODULE II (21ST CENTURY SKILLS AND PROBLEM SOLVING TECHNIQUES)

21st Century Skills*:* Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making- Lateral Thinking- Critical thinking Vs Creative thinking
Problem Solving Techniques: Six Thinking Hats- Mind Mapping- Forced Connections- Scientific temperament and Logical thinking with case studies. (Activity based learning)

MODULE III (GROUP DYNAMICS AND LEADERSHIP)

Group and Team Dynamics: Composition, Formation-Problem Solving in Groups-Group vs Team, Team Dynamics- Managing team performance(Activity based learning)
Leadership: Leadership Framework -Types of Leadership- VUCA Leadership- Transactional vs Transformational Leaders

MODULE IV (HUMAN VALUES)

Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue- Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment- Empathy-Self Confidence -Social Expectations.
Case study on Engineering disasters (Include study of Ethical issues in a recent disaster)
Code of Conduct in Engineering profession.

MODULE V (RESPONSIBILITIES AND RIGHTS)

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality-Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights-Employee right- IPR Discrimination
Global ethical issues- Business ethics, Computer Ethics, Environment ethics – Role in technological development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors.

Text books

1. Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publication, First Edition 2016
2. ICT Academy of Kerala, "Life Skills for Engineers", McGraw Hill Education (India) Private Ltd., 2016
3. Mike W Martin and Roland Schinzinger, Ethics in Engineering, 4th edition, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi,2014.

Reference books

1. Shiv Khera, You Can Win, Macmillan Books, New York, 2003
2. Barun K. Mitra, “Personality Development & Soft Skills”, Oxford Publishers, Third impression, 2017.
3. Shalini Verma, “Development of Life Skills and Professional Practice”; First Edition; Sultan Chand (G/L) & Company, 2014
4. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of

India, New Jersey, 2004.
5. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states,2005.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (8 Hours)	
1.1	Understanding Life Skills*:* Meaning and Significance of Life Skills- WHO-Identified Life Skills-Life skills for professionals	1
1.2	Self-awareness: Definition and Need-Tools and Techniques of Self-awareness	1
1.3	Activity based on Self-awareness	1
1.4	Activity based on Self-awareness	1
1.5	Stress Management: Stress, reasons and effects- stress diaries- Four A's of stress management	1
1.6	Coping with emotions: Identifying and managing emotions- PATH method and relaxation techniques	1
1.7	Activity based on Stress Management	1
1.8	Activity based on Stress Management	1
	MODULE II (7 Hours)	
2.1	21st Century Skills*:* Creativity, Critical Thinking, Collaboration, Problem Solving	1
2.2	Decision Making- Lateral Thinking- Critical thinking Vs Creative thinking (1 hour for exercise)	1
2.3	Activity based on Lateral Thinking, Critical and Creative thinking	1
2.4	Problem Solving Techniques: Six Thinking Hats- Mind Mapping- Forced Connections (2 hours for activity)	1
2.5	Activity based on problem solving techniques	1
2.6	Activity based on problem solving techniques	1
2.7	Scientific temperament and Logical thinking with case studies	1
	MODULE III (7 Hours)	
3.1	Group and Team Dynamics: Composition, Formation-Problem Solving in Groups	1
3.2	Group vs. Team, Team Dynamics- Managing team performance (2 hours for activity)	1

3.3	Activity based on Team Dynamics	1
3.4	Activity based on Team Dynamics	1
3.5	Leadership: Leadership Framework -Types of Leadership	1
3.6	VUCA Leadership	1
3.7	Transactional vs. Transformational Leaders	1
MODULE IV (7 Hours)		
4.1	Morals, values and Ethics – Integrity- Academic integrity	1
4.2	Work Ethics- Service Learning- Civic Virtue- Respect for others- Living peacefully	1
4.3	Honestly- courage-Cooperation commitment- Empathy	1
4.4	Self Confidence -Social Expectations.	1
4.5	Case study on Engineering disasters	1
4.6	Case study on Engineering disasters	1
4.7	Code of Conduct in Engineering profession	1
MODULE V (7 Hours)		
5.1	Collegiality and loyalty – Managing conflict- Respect for authority	1
5.2	Collective bargaining- Confidentiality-Role of confidentiality in moral integrity	1
5.3	Conflicts of interest- Occupational crime	1
5.4	Professional rights-Employee right- IPR Discrimination	1
5.5	Global ethical issues- Business, Engineering, Environment.	1
5.6	Role in technological development-Engineers as Managers-Consulting Engineers	1
5.7	Engineers as Expert witnesses and advisors.	1

CO Assessment Questions	
CO1	1. List 'life skills' as identified by WHO. 2. Explain the essential life skills required by a professional.
CO2	1. Illustrate the creative thinking process with the help of a suitable example 2. "Imagine you are tasked with addressing a complex environmental issue, such as reducing plastic waste in a coastal community". How would you apply the Six Thinking Hats technique to explore different facets of the problem and generate potential solutions?
CO3	1. "A group focuses on individual contribution, while a team must focus on synergy." Explain. 2. "Imagine you are part of a diverse team tasked with addressing a complex

	organizational challenge in a VUCA environment. Apply your knowledge of group formation and composition to strategically assemble a team that can effectively tackle the issue.
CO4	1. Define integrity and point out ethical values 2. Explain the role of engineers in modern society
CO5	1. Distinguish between self-interest and conflicts of interest 2. Explain the role of professional ethics in technological development.

24CEL307	CIVIL ENGINEERING DRAWING	L	T	P	J	S	C	Year of Introduction
		0	0	4	0	4	2	2024

Preamble: The objective of this course is to introduce the fundamentals of Civil Engineering drawing. During the course the students will understand the principles of planning and learn how to use a drafting tool and software. After the course the students will be able to prepare drawings of buildings using drafting software such as AutoCAD

Prerequisite: 24ESL116 Space Planning Lab.

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

CO1	Prepare drawings of building components. (Understand, Apply Level)
CO2	Prepare building drawings as per codal provisions (Apply Level)
CO3	Prepare a complete document for building permit to include all necessary information regarding drawing. (Apply Level)
CO4	Prepare a digital form of building plan using any drafting software (Apply Level).

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	2	-	-
CO2	3	-	-	-	-	-	-	3	-	3	-	-
CO3	3	-	-	-	-	-	-	2	-	2	-	-
CO4	2	-	-	-	2	-	-	-	-	2	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember	✓	✓
Understand	✓	✓
Apply	✓	✓
Analyse		
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Class work	Lab Exam	Total Marks
0-0-4-0	5	25	30	60

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2.5 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2	2 questions will be given from to draw building parts, out of	2 questions will be given from Building Drawing, out of which 1 question	40

	which 1 question should be answered. Each question carries 15 marks	should be answered. Each question carries 25 marks. Time: 2.5 hours	
	Total Marks: 15	Total Marks :25 marks	

SYLLABUS- DETAILS OF EXPERIMENTS

List of Experiments (Any 12 experiments out of 15 need to be performed
drafting using computer aided drafting software is mandatory for the experiments)

1. Draw plan, sectional details and elevation of paneled doors.
2. Draw plan, sectional details and elevation of glazed windows and ventilators in wood.
3. Draw sectional details, detailing on fixing arrangement and elevation of steel windows.
4. Draw elevation, section and detailing of connection between members, arrangement for fixing at the support for steel roof truss.
5. Draw plan, section and elevation of dog legged staircase.
6. Draw sectional details of a load bearing wall over strip footing, RCC Column over isolated footing and pile footing with pile cap.
7. Draw plan, section and elevation of single storied residential buildings with flat roof.
8. Draw plan, section and elevation of a two storied residential building.
9. Draw plan, section and elevation of a community hall having corrugated GI sheet roof.
10. Prepare a site plan and service plan as per latest building rules (KPBR or KMBR)
11. Prepare detailed drawing on building services (for single and two storied buildings only) and on-site wastewater disposal systems like septic tank and soak pit.
12. Draw plan, section and elevation of multi-storied framed buildings.
13. Draw plan, section and elevation of a public building – office complex, public health centre, post office, bank etc.
14. Draw plan, section and elevation of an industrial building with corrugated GI steel roof and PEB based walling elements.
15. Create 3D model of a two storied residential building and render the model.

Text books

1. Dr. Balagopal & T.S. Prabhu, Building Drawing and Detailing, Spades Publishers, Calicut.

Reference books

1. National Building Code of India.
2. Kerala Panchayat building rules, 2019.

3. Kerala Municipality building rules, 2019.
4. AutoCAD Essentials, Autodesk official Press, John Wiley & Sons, USA.
5. Shah, M.G., Kale, C. M. and Patki, S.Y. Building Drawing with an Integrated Approach to Built Environment, Tata McGraw Hill Publishing Company Limited, New Delhi.

Course Plan

No.	Experiments	No. of Hours (48)
1	Study on various parts of paneled door, joinery details, dimensions, scale to be taken while drawing.	2
2	Draw sectional details and elevation of paneled doors.	2
3	Explain the various parts of glazed windows and ventilators in wood, joinery details, dimensions, scale to be taken while drawing.	2
4	Draw plan, sectional details and elevation of glazed windows and ventilators in wood.	2
5	Study on detailing of connection between members, arrangement for fixing at the support for steel roof truss.	2
6	Draw elevation, section and detailing of connection between members, arrangement for fixing at the support for steel roof truss.	2
7	Explain how to find the number of rise and tread, when floor to floor height and room size are given. Draw plan, section and elevation of dog legged staircase.	2
8	Study on different types of footings and to prepare the drawings. Draw sectional details of a load bearing wall over strip footing, RCC column over isolated footing and pile footing with pile cap.	2
9	Explain how to plan and draw the plan, section and elevation of a single storey residential building with flat roof according to the requirement of the client and to prepare a digital form of building plan using a drafting software.	2
10	Draw plan, section and elevation of single storied residential buildings with flat roof.	2
11	Explain how to plan and draw the plan, section and elevation of a two storied residential building with flat roof according to the requirement of the client and to prepare a digital form of building plan using a drafting software.	2
12	Draw plan, section and elevation of a two storied residential building.	2

13	Explain how to plan and draw the plan, section and elevation of a single storied community hall with sloping roof with corrugated GI sheet roof.	2
14	Draw plan, section and elevation of a community hall having corrugated GI sheet roof.	2
15	Study of National Building Codes (NBC) and latest building rules (KPBR or KMBR).	2
16	Prepare a site plan and service plan as per latest building rules (KPBR or KMBR).	2
17	To give awareness about how to prepare detailed drawing on building services (for single and two storied buildings only) and on-site wastewater disposal systems like septic tank and soak pit along with the plan, section and elevation of residential building and to prepare a complete document for building permit to include all necessary information regarding drawing.	2
18	Prepare detailed drawing on building services (for single and two storied buildings only) and on-site wastewater disposal systems like septic tank and soak pit.	2
19	Explain framed buildings and unframed buildings.	2
20	Draw plan, section and elevation of multi-storied framed buildings.	2
21	To give awareness about how to prepare detailed drawing on public buildings and a digital form of building plan using any drafting software	2
22	Draw plan, section and elevation of a public building – office complex, public health centre, post office, bank etc.	2
23	Explain how to create a 3D model of a two storied residential building.	2
24	Create 3D model of a two storied residential building and render the model.	2

CO Assessment Questions	
CO1	Draw the plan and elevation of a single leaf wooden paneled door of dimension 110 cm x 200 cm. (Understand & Apply)
CO2	Draw the plan and sectional elevation of a dog-legged staircase for the following details: (Understand & Apply) Floor to floor height: 313 cm Roof slab thickness: 13 cm Width of stair-room: 200 cm.

CO3	Draw the plan and elevation of a single storey residential building with flat roof with following requirement and prepare a complete document for building permit.: (Understand & Apply) i. Bedroom-1 ii. Kitchen-1 iii. Toilet-1 iv. Living room-1 v. Dining room-1
CO4	Draw the plan and elevation of a single storey hospital building with flat roof with the following requirements and prepare a digital plan by using AUTOCAD: (Apply level) Doctor's room- 2 Patient's waiting room-1 Laboratory-1 X-ray room-1 Canteen-1 Injection room Toilet

MINOR COURSE

24CEM309	BUILDING CONSTRUCTION AND STRUCTURAL SYSTEMS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble:
The objective of the course is to enable the students to familiarize with the fundamental concepts of building construction. The course provides a detailed insight into the various building elements, construction technology, and structural systems to the students of other branches of Engineering. After the course, the students will be familiar with the fundamental concepts of building construction.

Prerequisite: Nil

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

CO1	Explain the properties and testing methods of different materials used for building construction. (Understand level)
CO2	Explain the construction details of different components of buildings. (Understand level)
CO3	Explain construction practices such as prefabricated, cost effective and sustainable technologies. (Understand level)
CO4	Explain the details and behavior of structural systems and structural elements used in buildings. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	2											
CO3	2											
CO4	2											

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	Theory [L- T]			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3hrs

End Semester Examination [ESE]: Pattern: 1

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60

SYLLABUS

MODULE I (Introduction to concrete technology)

Cement – Types, composition, manufacturing process, properties, tests. Aggregates – properties, tests. Mortar – types, properties, uses. Chemical admixtures – types, uses.

MODULE II (Properties of concrete)

Concrete – PCC, RCC. Properties of fresh concrete, Workability – tests. Properties of hardened concrete – tests for strength, Nominal mix and design mix.

MODULE III (Building components)

Flooring and roofing materials, Lintels and arches, Types and construction

details of doors, windows and ventilators. Finishing works, Timber products, Formwork.

MODULE IV (Construction technologies)

Foundations – shallow and deep, Cost effective construction, Sustainable building technologies, Non destructive testing of concrete, Prefabricated construction.

MODULE V (Structural elements)

Structural elements - beams, columns and slabs. Principles of reinforced concrete, types of reinforcements, Reinforcement details of structural elements, Structural systems, Concrete floor systems.

Text books

1) Punmia B. C., Building Construction, Laxmi Publications (P) Ltd.
2) Arora and Bindra, Building construction, Dhanpath Rai and Sons.
3) Shetty M.S., Concrete Technology, S. Chand & company.

Reference books

1 Madan Mehta, Walter Scarborough, Diane Armpriest (2017), Building Construction: Principles, Materials, Systems, Pearson India.
2 Daniel Schodek and Martin Bechthold, Structures, Pearson.
3 V. Sankara Subramaniyan, Construction Technology, Lakshmi Publications, Chennai.
4 S. S. Bhavikatti, Construction Technology, Chess Educational Publishers, Chennai
5 S. C. Rangwala and K. B. Dalal Building Construction Charotar Publishing house
6 P. C. Varghese, Building Materials, PHI Learning Pvt Ltd., Delhi.
7 W. C. Huntington, Building Construction, John Wiley
8 Mehta and Monteiro, Concrete - Microstructure, Properties and Materials, McGraw Hill Professional.
9 A. M. Neville and J. J. Brooks, Concrete Technology, Pearson Education.
10 R. Santhakumar, Concrete Technology, Oxford Publications

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (45)
	MODULE 1 (9 Hours)	
1.1	Cement – Types of cements, chemical composition. Blended cements.	1
1.2	Manufacturing of cement.	1
1.3	Properties and tests on cement.	1

1.4	Hydration of cement.	1
1.5	Aggregates – types, role of aggregates.	1
1.6	Properties of aggregates and tests.	1
1.7	Grading requirements. Natural and synthetic aggregates.	1
1.8	Mortar – types, Sand – properties, uses.	1
1.9	Water quality for construction. Chemical admixtures – types and uses.	1
MODULE II (10 Hours)		
2.1	Concrete – PCC, RCC and Prestressed concrete. (brief descriptions only)	1
2.2	Making of concrete – batching, mixing, transporting, placing, compacting.	1
2.3	Concrete- finishing and curing.	1
2.4	Properties of fresh concrete – workability, segregation and bleeding.	1
2.5	Factors affecting workability and strength – tests on workability.	1
2.6	Demonstration of slump test.	1
2.7	Effects of aggregates on properties of concrete.	1
2.8	Properties of hardened concrete – tests for strength of concrete in compression.	1
2.9	Tests for strength of concrete in tension and flexure.	1
2.10	Nominal mixes and design mixes, mix designations, ready mixed concrete.	1
MODULE III (8 Hours)		
3.1	Flooring and roofing materials.	1
3.2	Lintels and arches – types.	1
3.3	Doors– types and construction details.	1

3.4	Windows and ventilators – types and construction details.	1
3.5	Finishing works. Paint – types.	1
3.6	Timber – seasoning.	1
3.7	Timber products – properties and uses of plywood, fibre board and particle board.	1
3.8	Formwork, Construction and expansion joints.	1
MODULE IV (10 Hours)		
4.1	Types of shallow foundations.	1
4.2	Types of deep foundations.	1
4.3	Foundation failure – causes.	1
4.4	Introduction to cost effective construction – principles of filler slab.	1
4.5	Principles of rat-trap bond masonry.	1
4.6	Sustainable building technologies.	1
4.7	Sustainable building practices.	1
4.8	Non destructive testing of concrete – rebound hammer test and ultrasonic pulse velocity test.	1
4.9	Non destructive testing of concrete - demonstrations.	1
4.10	Introduction to prefabricated construction- advantages, slip form construction.	1
MODULE V (8 Hours)		
5.1	Introduction to structural systems – functions, Primary structural elements – beams, columns and slabs.	1
5.2	Principles of reinforced concrete, types of reinforcements – tension reinforcements.	1
5.3	Compression reinforcements and stirrups.	1
5.4	Reinforcement details of beams.	1

5.5	Reinforcement details of columns and slabs.	1
5.6	Structural systems – load bearing walls, moment resisting frames.	1
5.7	Structural systems – trusses, cables and membranes.	1
5.8	Elevated concrete floor systems, beams supported concrete floors – one way and two way slabs, flat slabs.	1

CO Assessment Questions	
CO1	Discuss the role of admixtures in concrete.
CO2	Explain the procedure adopted for laying marble flooring.
CO3	Explain the construction details of rat-trap bond masonry.
CO4	Distinguish between load bearing wall construction and moment resisting frame construction.

Semester 4

B.Tech (Civil Engineering) Curriculum - Semester 4

FOURTH SEMESTER												Total Marks	
Sl No	Slot	Code	Category	Title	L	T	P	J	S	Hours	Credits	CIA	ESE
1	A	24CET401	PCC	Structural Analysis	3	1	0	0	3	4	4	40	60
2	B	24CET402	PCC	Soil Mechanics	2	1	0	0	2	3	3	40	60
3	C	24CEP403	PCC	Fluid Mechanics	2	1	2	0	4	5	4	60	40
4	D	24CEJ404	PBC	Transportation Engineering	2	0	2	2	5	6	5	60	40
5	E	24HUT410	HSMC	Disaster Management and Resilient Infrastructure	3	0	0	0	3	3	3	40	60
6	F	24MCT406	MC	Environmental Sciences	3	0	0	0	3	3	1*	40	60
7	G	24CET407	PCC	Construction Technology	2	0	0	0	2	2	2	100	
8	M/H/R	24CEM409 / 24CEH409	MR/HR/RL	MINOR/HONOURS/ REMEDIAL	4	0	0	0			4/4/0	40	60
TOTAL									22	26	22		

Honours and Minor Courses

Minor in Civil Engineering

24CEM409	CLIMATE CHANGE AND SUSTAINABILITY

HONOURS					
BASKET 1		**BASKET 2**		**BASKET 3**	
STRUCTURAL ENGINEERING AND CONSTRUCTION MANAGEMENT		**TRANSPORTATION AND GEOTECHNICAL ENGINEERING**		**WATER RESOURCES AND ENVIRONMENTAL ENGINEERING**	
24CEH419	MODERN CONSTRUCTION MATERIALS	24CEH429	TRANSPORTATION DATA ANALYSIS	24CEH439	ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

24CET401	STRUCTURAL ANALYSIS	L	T	P	J	S	C	Year of Introduction
		3	1	0	0	3	4	2024

Preamble: This course aims to introduce techniques to analyze both statically determinate and indeterminate structures. The course enables students to understand the basic behavior of skeletal structures and their responses to applied loads, as well as introduces the students to plastic theory and dynamic analysis of structures. After the completion of the course, the student will be able to analyze both statically determinate and indeterminate structures using elastic and plastic theory and analyze SDOF systems subjected to harmonic loading.

Prerequisite: 24CEP303 Mechanics of Solids

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

CO1	Analyse trusses using method of sections and method of joints. [Apply level]
CO2	Illustrate the structural action of structures like cables, suspension bridges and arches and analyse them. [Understand and apply level]
CO3	Determine deflections in statically determinate structures. [Apply level]
CO4	Identify indeterminacies and discuss the methods of analysis of indeterminate structures. [Understand level]
CO5	Analyse indeterminate structures such as continuous beams and portal frames. [Apply level]
CO6	Apply the principles of plastic theory to analyse indeterminate structures. [Apply level]
CO7	Analyse SDOF systems subjected to harmonic loading. [Apply level]

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	-	-	-	-	-	-	-	-	-	-
CO2	**3**	**3**	-	-	-	-	-	-	-	-	-	-
CO3	**3**	**3**	-	-	-	-	-	-	-	-	-	-
CO4	**3**	**1**	-	-	-	-	-	-	-	-	-	-
CO5	**3**	**3**	-	-	-	-	-	-	-	-	-	-
CO6	**3**	**3**	-	-	-	-	-	-	-	-	-	-
CO7	**3**	**3**	-	-	**3**	-	-	-	-	-	-	**3**

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				

Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-1-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Trusses, Arches and Cables)

Analysis of Statically determinate structures:

Determination of forces in trusses, arches and cables:

Trusses: Method of joints and method of sections. (simple illustrative numerical problems only)

Arches: Theory of arches – Eddy's theorem; Analysis of three-hinged arches; Normal

thrust and radial shear due to simple cases of loading.

Cables: Analysis of forces in cables under concentrated and uniformly distributed loads; Anchor Cable supports.

Moving loads and influence lines: Introduction to moving loads - concept of influence lines - influence lines for reaction, shear force and bending moment in simply supported beams. (Concept only)

MODULE II (Deflection of statically determinate structures)

Deflection of statically determinate structures:

a) Method of successive integrations. (simple illustrative examples of simple beams and cantilever beams)

b) Moment area method. (concept only)

c) Conjugate beam method.

d) Unit load method for determination of deflection of statically determinate beams and trusses.

Castigliano's theorem Part I, Principle of virtual work, Betti's theorem, Maxwell's law of reciprocal deflections. (Theorems only)

MODULE III (Analysis of Statically Indeterminate Structures)

Statically Indeterminate Structures: Degree of static and kinematic indeterminacies; Introduction to force and displacement methods.

Method of consistent deformations: Analysis of beams (simple problems with one redundant, illustration only for two-redundant problems). Concepts of effect of pre-strain, lack of fit, temperature changes and support settlement. (No numerical problems)

Slope Deflection Method: Analysis of continuous beams and portal frames without sway; Frames with sway (illustration only); Settlement effects (Illustration only)**.**

MODULE IV (Plastic Analysis)

Introduction to matrix method of analysis: Concept of stiffness matrix and flexibility matrix.

Plastic Theory: Introduction – plastic hinge concepts – plastic modulus – shape factor – redistribution of moments – collapse mechanisms – Plastic analysis of beams and portal frames by equilibrium and mechanism methods. (single storey and single bay frames only).

MODULE V (Introduction to Structural Dynamics)

Structural dynamics: Introduction – dynamic loading - degrees of freedom - equation of motion, D'Alembert's principle - stiffness - damping - Free response of undamped and damped systems - logarithmic decrement - single degree of freedom systems subjected to harmonic load - transient and steady state responses.

Text books

1. Devdas Menon, Structural Analysis, Narosa Publishing House.
2. Junnarkar S. B., Mechanics of Structures Vol I & II, Charotar Publishing House.
3. Mario Paz, Structural Dynamics, Springer Nature Switzerland, 1979.
4. Duggal S. K., Design of Steel Structures, Tata McGraw-Hill Publishing.

Reference books

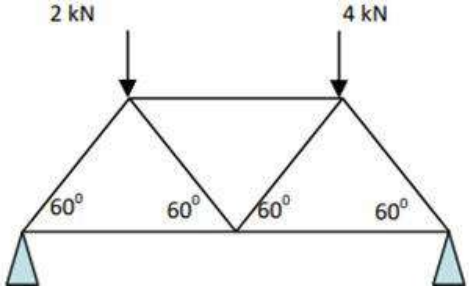
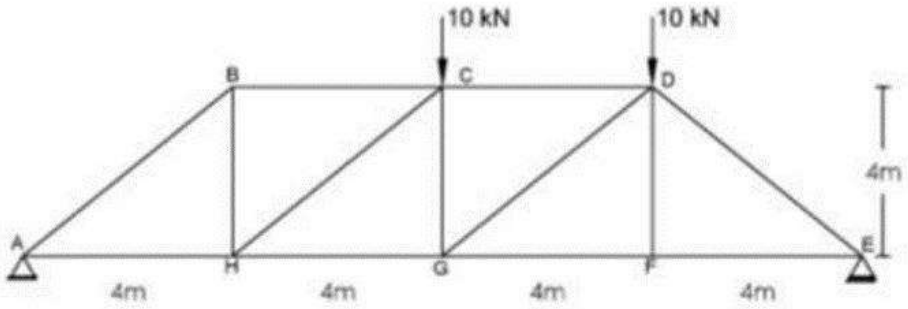
1. H. H. West, Fundamentals of Structural analysis, Wiley, New York, 1993.
2. C. H. Norris, J. B. Wilbur and S. Uktu, Elementary structural Analysis, 3rd Ed., McGraw Hill International, Tokyo, 1976.
3. C. S. Reddy, Basic Structural Analysis, 2nd Edition, Tata, Mc Graw Hill, New Delhi, 1996.
4. M. L. Gambhir, Fundamentals of structural Mechanics and analysis, Printice Hall India.
5. Timoshenko S. P. & Young D. H., Theory of Structures, McGraw Hill.
6. Negi L. S. and Jangid R. S., Structural Analysis, Tata McGraw Hill, 1997.
7. Punmia B. C., Strength of Materials and Mechanics of Structures, Laxmi Publications.

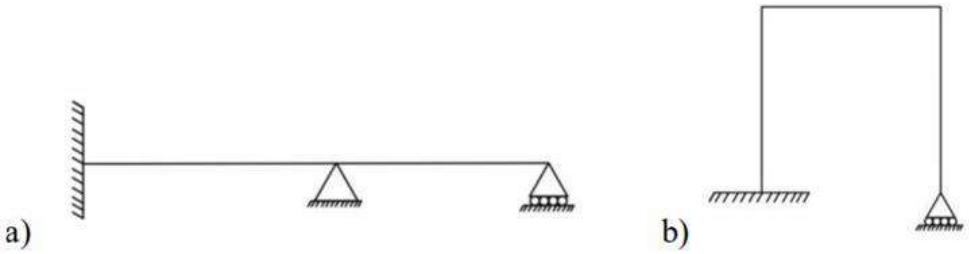
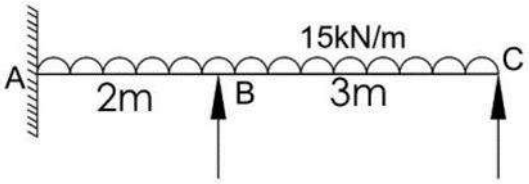
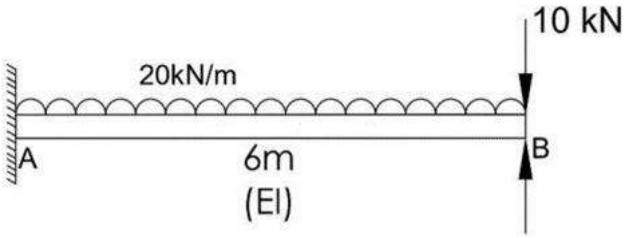
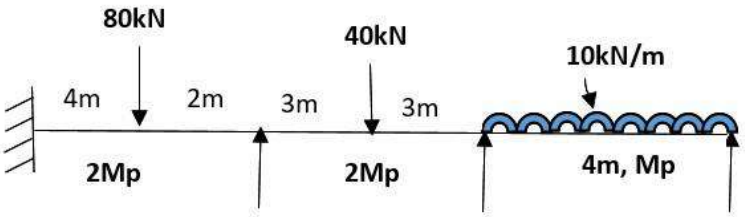
COURSE CONTENTS AND LECTURE SCHEDULE

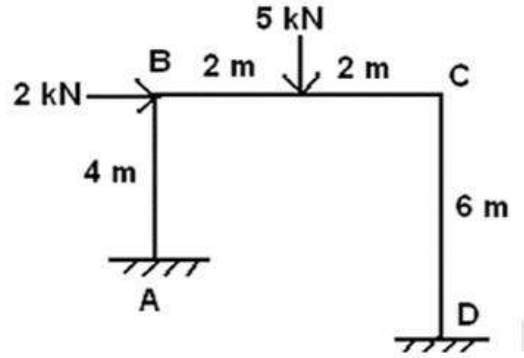
No.		No. of Hours (48)
	MODULE 1 (9 Hours)	
1.1	Introduction to truss analysis- Structural action of trusses- Illustration of Method of joints.	1
1.2	Illustration of Method of sections.	1
1.3	Tutorial (Analysis of trusses using method of sections and method of joints)	1
1.4	Arches: Introduction - structural action of arches - comparison of beams and arches -Classification of arches - Internal forces in arches – BM, radial shear and normal thrust.	1
1.5	Tutorial (Parabolic and Segmental arches)	1
1.6	Introduction to cables- structural action- behaviour of cables under concentrated and uniformly distributed loads – Types of supports.	1
1.7	Analysis of forces in cables under concentrated and uniformly distributed loads.	1
1.8	Tutorial (Forces in cables)	
1.9	Moving loads and influence lines: Introduction to moving loads - concept of influence lines - influence lines for reaction, shear force and bending moment in simply supported beams. (Concept Only)	1
	MODULE II (10 Hours)	
2.1	Introduction to deflection computation, Euler Bernolli Equation, Illustration of Method of successive integrations.	1
2.2	Illustration of Mc Cauly's Method.	1

2.3	Moment area theorems, Illustration with simple example (concept only).	1
2.4	Conjugate beam method – conjugate beams - Illustration using simple problems.	1
2.5	Tutorial (Double Integration Method, Mc Cauly's Method and Conjugate beam method)	1
2.6	Concept of virtual work, Explanation of virtual work principle. Unit load method from principle of virtual work.	1
2.7	Unit load method for determination of deflection - Illustrative examples on beams.	1
2.8	Unit load method for determination of deflection - Illustrative examples on trusses.	1
2.9	Castigliano's theorem Part I, Betti's theorem, Maxwell's law of reciprocal deflections. (Theorems only)	1
2.10	Tutorial (Unit Load Method)	1
MODULE III (11 Hours)		
3.1	Introduction to Analysis of Statically Indeterminate Structures: Concept of Static and Kinematic Indeterminacy and its determination in beams, frames and trusses.	1
3.2	Basic idea on force and displacement methods of analysis of indeterminate structures.	1
3.3	Method of consistent deformations: Introduction, Concept of the method, illustration with simple example.	1
3.4	Numerical problems on continuous beams (simple problems with one redundant, illustration only for two-redundant problems).	1
3.5	Tutorial (Method of consistent deformations)	1
3.6	Concepts of effect of pre-strain, lack of fit, temperature changes and support settlement. (No numerical problems)	1
3.7	Slope Deflection Method - concept - derivation of slope deflection equation - Discussion on support settlement.	1
3.8	Analysis of continuous beams - Numerical problems.	1
3.9	Analysis of portal frames without sway - Concept of Sway in frames, Analysis of Non sway frames - examples.	1
3.10	Analysis of Portal Frames with sway - Illustration of non-sway portal frames.	1
3.11	Tutorial (Slope Deflection Method)	1
MODULE IV (9 Hours)		
4.1	Introduction to matrix method of analysis - Need of Matrix methods.	1

4.2	Concept of stiffness matrix and flexibility matrix - Concept of stiffness equation and flexibility equation.	1
4.3	Introduction to plastic analysis, Comparison with elastic analysis, Theory of Plastic Analysis, plastic hinge concepts.	1
4.4	Plastic modulus – shape factor	1
4.5	Redistribution of moments – collapse mechanisms - Basic theorems of plastic analysis.	1
4.6	Methods of plastic analysis (equilibrium and mechanism method)	1
4.7	Plastic analysis of beams – Examples.	1
4.8	Plastic analysis of portal frames – Examples (Single storey and single bay frames only).	1
4.9	Tutorial (Plastic Analysis)	1
MODULE V (9 Hours)		
5.1	Introduction to structural dynamics, Dynamic loading – types. Harmonic loading.	1
5.2	Characteristics of a dynamic problem – difference between static response and dynamic response. Brief description of dynamic analysis, Parameters of a dynamic system – mass, stiffness and damping.	1
5.3	Degree of freedom of a dynamic system. SDOF, MDOF and continuous systems – examples. Computation of stiffness of SDOF systems.	1
5.4	D'Alembert's principle – Equation of motion of SDOF spring-mass systems. Equation of motion of general SDOF systems.	1
5.5	Free vibration analysis of undamped systems – concept of natural frequency. Response of systems to initial conditions.	1
5.6	Tutorial (Equation of motion, Natural frequency, Free vibration response)	1
5.7	Free vibration Response of damped systems. Measurement of damping – logarithmic decrement.	1
5.8	Response of SDOF spring-mass systems to harmonic loading – transient and steady state response.	1
5.9	Tutorial (Response of damped system, Response of SDOF systems to harmonic load)	1

CO Assessment Questions	
CO1	1. Analyse the truss in figure using method of joints.  2. Find the member forces in members BC, BH, AH, CD, GD, and GF using method of sections. 
CO2	1. For a cable AB, the level difference between the supports A and B is 6 m, and the lowest point is at a vertical distance of 4.5 m from A. If the horizontal span AB is 24 m and is loaded with 7.5 kN/m throughout the span, find the length of the cable, and the minimum and maximum tension in the cable. 2. A 3-hinged parabolic arch has a span of 30 m and the rise is 6 m. The arch is loaded with a concentrated load of 25 kN at 4 m from the left end. Find BM, normal thrust, and radial shear at a section 7.5 m from the left hinge. Find maximum BM on the arch.
CO3	1. Find the deflection at mid span and maximum deflection of a simply supported beam loaded as shown in figure. EI is constant throughout. 2. Compute the deflection produced at the mid span of a simply supported beam subjected to a concentrated load W each at left quarter span and right quarter span using Unit Load Method. EI is constant throughout.
CO4	1. Define Kinematic indeterminacy and determine the kinematic indeterminacy of following structures.

	 2. Distinguish between force and displacement method of analysis.
CO5	1. Analyse the continuous beam shown in figure by slope- deflection method and draw the Bending Moment Diagram.  2. Analyse the beam shown in figure by consistent deformation method and draw the Bending Moment Diagram. 
CO6	1. Find the plastic moment capacity required for the design of the continuous beam shown in the figure.  2. Find the plastic moment capacity required in the portal frame shown in figure. Assume uniform section throughout.

	
CO7	1. A vibrating system consists of a weight of W = 100 kN and a spring with stiffness k = 20 N/m is viscously damped so that the ratio of two consecutive amplitudes is 1/0.85. Determine: a) the natural frequency of the undamped system b) the damping ratio c) the damping coefficient and d) the damped natural frequency. 2. Find the response of a single degree of freedom damped spring-mass system subjected to harmonic load and generate the time history of displacement. Mark transient state and steady state parts. Use appropriate values of system and load parameters.

24CET402	SOIL MECHANICS	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: This course intends to impart knowledge of soil as an engineering material to the students. It covers the fundamental concepts of soil mechanics that include the determination and interpretation of basic, index, and engineering properties of soils. After this course, students will be able to identify and classify the soil, recognize practical problems in real-world situations, and respond accordingly.

Prerequisite: 24EST305 Engineering Geology

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

CO 1	Explain the fundamental concepts of basic and engineering properties of soil (Remember and understand level)
CO 2	Describe the laboratory testing methods for determining soil parameters (Understand level)
CO 3	Solve the basic properties of soil by applying phase and functional relationships (Apply level)
CO 4	Calculate the index and engineering properties of soil by applying the laboratory test results and the fundamental concepts of soil mechanics (Apply level)
CO 5	Interpret the soil properties and classify the soil (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-
CO 4	2	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
2-1-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Basic soil properties)

Nature of soil and functional relationships: Introduction to soil mechanics – 3 phase system – Basic soil properties: Void ratio, porosity, degree of saturation, air content, water content, specific gravity, unit weight - Relationship between basic soil properties - Numerical problems.

Determination of water content by oven drying, Specific gravity using pycnometer & specific gravity bottle - Numerical problems.

MODULE II (Index properties)

Index properties: Sieve analysis – Well graded, poorly graded and gap graded soils - Stoke's law – Hydrometer analysis [derivation and experimental procedure not required] – Relative Density - Numerical problems - Consistency – Atterberg Limits and indices – Plasticity charts - laboratory tests for Liquid Limit, Plastic Limit &

Shrinkage Limit - Numerical problems.
IS classification of soil - Numerical problems.
Permeability of soils: Darcy's law – Factors affecting permeability – Laboratory tests: Constant head and falling head permeability tests - Numerical problems - Average permeability of stratified deposits - numerical problems - Basic terms in seepage analysis, Flow net - Flowlines and Equipotential lines.

MODULE III (Effective stress and Vertical stress)

Principle of effective stress - Total, neutral and effective stress – Pressure diagrams - Numerical problems - Pressure diagrams in soils saturated by capillary action – Quick sand condition – Critical hydraulic gradient.
Stress distribution: Introduction - Boussinesq's equations for vertical pressure due to point loads and line loads – Assumptions and Limitations - Numerical problems - Vertical pressure due to uniformly distributed loads beneath strip, circular and rectangular shapes [no derivation required] - Numerical problems - Pressure Isobars - Pressure bulbs – Newmark's charts (Construction procedure not required) and their use. Westergaard's theory, Difference between Westergaard and Boussinesq theories.

MODULE IV (Engineering properties – Consolidation and compaction)

Consolidation - Definition – Terzaghi's theory of one-dimensional consolidation (no derivation required) - average degree of consolidation – Time factor - Coefficient of consolidation - Numerical problems - Concepts of Coefficient of compressibility and volume compressibility - e-log p curve - Normally consolidated, over consolidated and under consolidated soils - Compression index, Recompression index and Pre consolidation Pressure - Estimation of magnitude of settlement of normally consolidated clays - Numerical problems – Laboratory consolidation test – Determination of Coefficient of Consolidation - Practical Applications.
Compaction of soils - Difference between consolidation and compaction -– OMC and MDD - Zero Air voids line - Numerical problems - Control of compaction - Field compaction methods - Proctor needle for field control.

MODULE V (Engineering properties – Shear strength)

Shear strength of soils - Practical Applications - Mohr-Coulomb failure criterion - Mohr circle method for determination of principal planes and stresses – relationship between shear parameters and principal stresses - Numerical problems.
Brief discussion of Laboratory tests - Triaxial compression test - UU, CU and CD tests - Total and effective stress strength parameters - Unconfined compression test, Direct shear test – Applicability - Numerical problems.
Soil Structure and their effects on the basic soil properties – Sensitivity and Thixotropy.

Text books

1. Ranjan G. and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2016.
2. Arora K. R., Geotechnical Engineering, Standard Publishers, 2006.

Reference books

1. Das B. M., Principles of Geotechnical Engineering, Cengage India Pvt. Ltd., 2010.
2. Venkatramaiah, Geotechnical Engg, Universities Press, 2000.
3. Ramamurthy T. N. and T. G. Sitharam, Geotechnical Engineering, S. Chand and Company Ltd.
4. Terzaghi K. and R. B. Peck, Soil Mechanics in Engineering Practice, John Wiley, 1967.
5. Narasimha Rao A. V. and C Venkatramaiah, Numerical Problems, Examples and Objective questions in Geotechnical Engineering, Universities Press (India) Ltd., 2000.
6. Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Indersley (India) Pvt. Ltd., 2013.
7. Taylor D.W., Fundamentals of Soil Mechanics, Asia Publishing House, 1948.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (6 Hours)	
1.1	Nature of soil and functional relationships: Introduction to soil mechanics – 3 phase system – Basic soil properties: Void ratio, porosity, degree of saturation, air content, water content, specific gravity, unit weight.	1
1.2	Relationship between basic soil properties.	1
1.3	Numerical problems.	1
1.4	Numerical problems.	1
1.5	Determination of Water content by oven drying, Specific gravity using pycnometer & specific gravity bottle.	1
1.6	Numerical problems.	1
	MODULE II (8 Hours)	
2.1	Index properties: Sieve analysis – Well graded, poorly graded and gap graded soils.	1
2.2	Stoke's law – Hydrometer analysis [derivation and experimental procedure not required] – Relative Density.	1
2.3	Numerical problems.	1
2.4	Consistency – Atterberg Limits and indices – Plasticity charts.	1
2.5	Numerical problems.	1
2.6	IS classification of soil - Numerical problems.	1
2.7	Permeability of soils: Darcy's law – Factors affecting permeability – Laboratory tests: Constant head and falling head permeability tests.	1
2.8	Average permeability of stratified deposits - numerical problems- Flow net- Flowlines and Equipotential lines, Applications of flow net.	1

MODULE III (8 Hours)		
3.1	Principle of effective stress - Total, neutral and effective stress – Pressure diagrams.	1
3.2	Numerical problems.	1
3.3	Pressure diagrams in soils saturated by capillary action – Quick sand condition – Critical hydraulic gradient.	1
3.4	Stress distribution: Introduction - Boussinesq's equations for vertical pressure due to point loads and line loads – Assumptions and Limitations.	1
3.5	Numerical problems.	1
3.6	Vertical pressure due to uniformly distributed loads beneath strip, circular and rectangular shapes. [no derivation required]	1
3.7	Numerical problems.	1
3.8	Pressure Isobars - Pressure bulbs – Newmark's charts (Construction procedure not required) and their use. Westergaard's theory, Difference between Westergaard and Boussinesq theories.	1
MODULE IV (8 Hours)		
4.1	Consolidation - Definition – Terzaghi's theory of one-dimensional consolidation (no derivation required) - average degree of consolidation – Time factor - Coefficient of consolidation.	1
4.2	Numerical problems.	1
4.3	Concepts of Coefficient of compressibility and volume compressibility - e-log p curve - Normally consolidated, over consolidated and under consolidated soils.	1
4.4	Compression index, Recompression index and Pre consolidation Pressure - Estimation of magnitude of settlement of normally consolidated clays.	1
4.5	Numerical problems.	1
4.6	Laboratory consolidation test – Determination of Coefficient of Consolidation - Practical Applications.	1
4.7	Compaction of soils - Difference between consolidation and compaction - OMC and MDD - Zero Air voids line.	1
4.8	Numerical problems, Control of compaction - Field compaction methods - Proctor needle for field control.	1
MODULE V (6 Hours)		
5.1	Shear strength of soils - Practical Applications - Mohr-Coulomb failure criterion.	1
5.2	Mohr circle method for determination of principal planes and stresses – relationship between shear parameters and principal stresses.	1
5.3	Numerical problems.	1

5.4	Brief discussion of Laboratory tests - Triaxial compression test - UU, CU and CD tests - Total and effective stress strength parameters.	1
5.5	Unconfined compression test, Direct shear test– Applicability.	1
5.6	Numerical problems. Soil Structure and their effects on the basic soil properties – Sensitivity and Thixotropy.	1

CO Assessment Questions		
CO 1	1	Write the relationship between (i) Void ratio, degree of saturation, water content and specific gravity. (ii) Bulk density and dry density. (iii) Write expression for γ, γ_d, γ_{sat}, γ_{sub}.
	2	Define void ratio, porosity, specific gravity, degree of saturation and dry density.
CO 2	1	Describe the procedure of liquid limit determination using Casagrande apparatus.
	2	Compare the direct shear and triaxial compression test.
CO 3	1	A partially saturated soil sample obtained from an earth fill has a natural moisture content of 22 % and unit weight of 19.6 kN/m^3. Assuming specific gravity of solids as 2.7 compute (a) Degree of saturation (b) Void ratio (c) If subsequently soil gets saturated determine its unit weight.
	2	The in-situ density of an embankment compacted at a water content of 12 % was determined with the help of a core cutter. The empty weight of the cutter was 1286 g and the cutter full of soil had a mass of 3195 g, the volume of the cutter being 1000 cm^3. Determine the bulk density, dry density and the degree of saturation of the embankment (Ans: 1.909 g/cc, 1.704 g/cc, 55.4 %). If the embankment is fully saturated during rain, what would be its water content and saturated unit weight? Assume no volume change in soil on saturation. Take the sp. gravity of the soil as 2.70.
CO 4	1	A soil sample has 97 % of particles (by weight) finer than 1 mm, 58 % finer than 0.1 mm, and 25 % finer than 0.01 mm and 12 % finer than 0.001 mm. Draw given size distribution curve and determine the C_u and C_c values.
	2	The results of triaxial shear tests are given below:

Specimen No.	1	2
Minor principal stress (σ_3) (kN/m^2)	17	44
Major principal stress (σ_1) (kN/m^2)	157	204
Pore Pressure (U) (kN/m^2)	12	20

<table>
<tr><td></td><td></td><td colspan="8">Determine the shear strength parameters using effective stress analysis.</td></tr>
<tr><td rowspan="3">CO 5</td><td>1</td><td colspan="8">An 8 m thick clay layer with single drainage settles by 120 mm in 2 yrs. The coefficient of consolidation of clay was found to be 6×10^{-3} cm/s. Calculate the likely ultimate consolidation settlement and find out how long it will take to undergo 90 percent of this settlement.</td></tr>
<tr><td rowspan="2">2</td><td colspan="8">The results of a particle size analysis of a soil are given in the following table. No Atterberg limit tests were conducted.</td></tr>
<tr><td>Sieve size (mm)</td><td>10</td><td>4.75</td><td>2</td><td>1</td><td>0.6</td><td>0.15</td><td>0.075</td></tr>
<tr><td>% N</td><td>100</td><td>89</td><td>70</td><td>62</td><td>50</td><td>29</td><td>4</td></tr>
<tr><td colspan="9">(a) Would you conduct Atterberg limit tests on this soil? Justify your answer.
(b) Classify the soil according to IS classification.
(c) Is this soil a good foundation material? Justify your answer.</td></tr>
</table>

24CEP403	FLUID MECHANICS	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: This course provides the fundamental concepts of mechanics of fluids and helps students to develop their analytical and problem-solving abilities. The course introduces students to the concepts and applications of hydrostatics, hydro dynamics, conservation of mass, energy and momentum. After this course, students will also be able to determine the discharge through pipes and channels.

Prerequisite: Elementary Mathematics(24MAP101, 24MAP201, 24MAT301), 24EST106Engineering Mechanics

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

CO1	Determine the fluid pressure, perform the stability check of bodies under hydrostatic condition (Apply level)
CO2	Identify or describe the type, characteristics or properties of fluid flow (Understand level)
CO3	Compute discharge through pipes and orifices by applying the principles of energy and continuity (Apply level)
CO4	Analyse the flow through pipes or estimate the forces on pipe bends by applying the hydraulic principles of continuity, energy and momentum (Analyse level)
CO5	Compute the discharge through channels from measurement data (Apply level)
CO6	Determine the hydraulic co-efficient by performing suitable experiments (Apply level)
CO7	Perform the calibration of hydraulic instruments by conducting suitable experiments (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-
CO6	3	3	-	-	-	-	-	3	3	3	-	3
CO7	3	3	-	-	-	-	-	3	3	3	-	3

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse		✓		✓
Evaluate				

Create				

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember	✓	✓
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	60	40	2.5hrs

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Hydrostatics)

Introduction to the subject - Fluid properties (mass density, specific weight, viscosity, specific gravity), Classification of Fluids. (prerequisite no questions from this section)

Fluid statics - variation of pressure in a fluid, measurement of fluid pressure using piezometers and manometers, U-tube manometers, Forces on immersed plane placed vertical and inclined positions. Hydrostatic force on curved surfaces; Practical application of hydrostatic pressure on spillway gates.

MODULE II (Stability and Hydrodynamics)

Buoyancy and Floatation: Buoyant force, Principle of floatation, stability of floating and submerged bodies, metacentre and metacentric height, analytical and experimental determination of metacentric height - problems.

Hydrodynamics - Fluid Kinetics and Kinematics. Fluid Kinematics - Methods of describing fluid motion, Lagrangian and Eulerian methods, velocity and acceleration, types of fluid flow, description of fluid flow - streamline, pathline and streakline; continuity equation in one, two and three dimensions.

MODULE III (Fluid kinetics)

Fluid kinetics - Forces considered in describing fluid motion, Derivation of Bernoulli's equation by integration of Euler's equation along a streamline, Applications of Bernoulli's equation for discharge computation - Venturimeter, Pitot tube and Orificemeter, Hydraulic coefficients of orifices and their experimental determination, Discharge through small orifice and large rectangular orifices.

MODULE IV (Pipe flow)

Pipe flow - computation of major and minor losses in pipes, hydraulic gradient line and total energy line, pipes in series - equivalent pipe, flow through parallel pipes; Flow through pipe bends in horizontal and vertical planes - application of linear momentum principle.

MODULE V (Flow measurement in channels)

Open channels - Types and Geometric Elements Flow measurement in channels – notches and weirs – Discharge computations using weirs - velocity of approach and end contraction, discharge equations of rectangular weir, triangular weir, trapezoidal and Cipoletti weir, submerged weir, broad crested weir.

Text books

1. Kumar D. N. Fluid Mechanics and Fluid power Engineering, S.K. Kataria & sons, 2013.
2. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002.

Reference books

1. Arora. K. R. Fluid Mechanics, Hydraulics and Hydraulic Machines, Standard Publishers, 2005.
2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2005.
3. Bruce R. Munson, Donald F. Young. Fundamentals of Fluid Mechanics, John Wiley & sons, 2011.
4. Frank M. White, Fluid Mechanics, Mc Graw Hill, 2013.
5. Jain A. K., Fluid Mechanics, Khanna Publishers, Delhi, 1996.
6. Joseph Katz, Introductory Fluid Mechanics, Cambridge University Press, 2015.
7. Streeter V. L., Fluid Mechanics, Mc Graw Hill Publishers.

COURSE CONTENTS AND LECTURE SCHEDULE

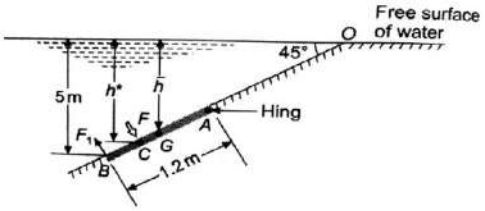
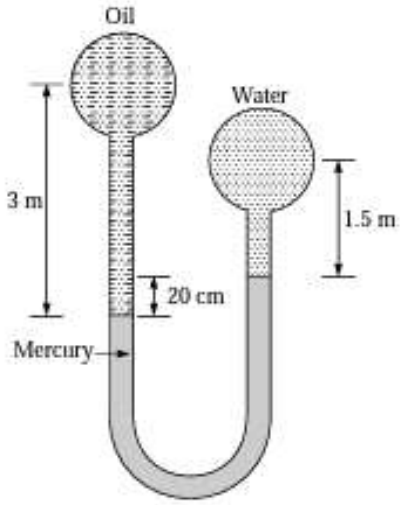
No.		No. Of Hours (36)
	MODULE I (8 Hours)	
1.1	Introduction to the subject - Fluid properties (mass density, specific weight, viscosity, specific gravity), Classification of Fluids. (prerequisite no questions from this section)	1
1.2	Fluid statics - variation of pressure in a fluid, Measurement of fluid pressure using piezometers.	1
1.3	Measurement of fluid pressure using U-tube manometers and differential manometers.	1
1.4	Tutorial - Measurement of fluid pressure.	1
1.5	Forces on immersed plane placed in vertical and inclined positions- Derivation.	1
1.6	Estimation of hydrostatic force on objects placed in vertical and inclined planes.	1
1.7	Hydrostatic force on curved surfaces- Practical applications on estimation of hydrostatic pressure on spillway gates.	1
1.8	Tutorial - Hydrostatic force on curved surfaces.	1
	MODULE II (8 Hours)	
2.1	Buoyancy and Floatation: Buoyant force, Principle of floatation.	1
2.2	Stability of floating and submerged bodies - Metacentre, Metacentric height.	1

2.3	Analytical and experimental determination of Metacentric height - Practical applications.	1
2.4	Tutorial - estimation of stability of floating bodies.	1
2.5	Hydrodynamics-Fluid Kinetics and Kinematics. Fluid Kinematics - Types and description of fluid flow, streamline, pathline and streakline.	1
2.6	Velocity and acceleration of fluids - Problems.	1
2.7	Continuity equation in one, two and three dimensions.	1
2.8	Tutorial-Flow properties and continuity equation.	1
MODULE III (7 Hours)		
3.1	Fluid kinetics - forces considered in describing fluid motion - Derivation of Bernoulli's equation by integration of Euler's equation along a streamline.	1
3.2	Practical applications of Bernoulli's equation for pipe flow, Venturimeter.	1
3.3	Practical applications of Bernoulli's theorem- Problems.	1
3.4	Applications of Bernoulli's theorem -Pitot tube and Orificemeter.	1
3.5	Tutorial-Applications of Bernoulli's theorem.	1
3.6	Hydraulic coefficients of orifices and their experimental determination, Discharge through small orifice.	1
3.7	Computation of discharge through large rectangular orifices.	1
MODULE IV (7 Hours)		
4.1	Pipe flow - computation of major and minor losses in pipes.	1
4.2	Hydraulic gradient line and total energy line, pipes in series - equivalent pipe.	1
4.3	Flow through pipes arranged in series and parallel - problems.	1
4.4	Determination of flow through pipe system with series and parallel arrangements.	1
4.5	Tutorial – Pipe flow computations.	1
4.6	Application of linear momentum - Flow through pipe bends in horizontal planes.	1

4.7	Flow through pipe bends in vertical planes.	1
MODULE V (6 Hours)		
5.1	Open channels - Types and Geometric Elements.	1
5.2	Discharge computation – Chezy's, Manning's and Kutter's formula. (no derivation)	1
5.3	Flow measurement in channels – Notches and weirs; Discharge computations using rectangular weir and triangular weir.	1
5.4	Effect of Velocity of approach and end contraction in the discharge computations using weirs.	1
5.5	Discharge computations - Trapezoidal weir, Cipoletti weir, submerged weir and broad crested weir.	1
5.6	Tutorial - Flow measurement.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Pressure measurement	2	Calibration of Pressure gauges
2	Stability of floating bodies	2	Determination of metacentric height of floating bodies
3	Bernoulli's theorem	2	Verification of Bernoulli's theorem
4	Orifice coefficients	2	Determination of Hydraulic coefficients of orifices
5	Applications of Bernoulli's theorem	2	Calibration of Venturimeter
6	Applications of Bernoulli's theorem	2	Calibration of Orificemeter
7	Discharge measurement through channels	2	Calibration of rectangular and triangular notches
8	Computation of major and minor losses in pipes	2	Determination of Darcy's and Chezy's constant for pipe flow
9	Discharge computation through open Channels	2	Determination of Chezy's constant and Manning's number for open channel flow
10	Computation of major and minor losses in pipes	2	Determination of friction co-efficient in pipes

CO Assessment Questions	
CO1	1. An inclined rectangular sluice gate AB 1.2 m by 5 m as shown in Fig. is installed to control the discharge of water. The end A is hinged. Determine the force normal to gate applied at B to open it.  2. Two pipelines, one carrying oil of relative density 0.9 and other carrying water are connected to a manometer as shown in Figure. By what amount, the pressure in water pipeline should be increased so that mercury levels in both the limbs of the manometer become equal?  3. A square aperture in the vertical side of a tank has one diagonal vertical and is completely covered by a plane plate hinged along one of the upper sides of the aperture. The diagonals of the aperture are 2 m long and the tank contains a liquid of specific gravity 1.15. The centre of aperture is 1.5 m below the free surface. Calculate the thrust exerted on the plate by the liquid and position of its centre of pressure. 4. A ship 70 m long and 10 m broad has a displacement of 19620 kN. A weight of 343.35 kN is moved across the deck through a distance of 6 m. The ship is tilted through 6°. The moment of inertia of the ship at water-line about its fore and aft axis is 75% of M.O.I. of the circumscribing rectangle. The centre of buoyancy is 2.25 m below water-line. Find the meta-centric height and position of centre of gravity of ship. Specific weight of sea water is 10104 N/m^3.

CO2	1. Derive the continuity equation in 3 dimensional Cartesian coordinates. 2. Differentiate Rotational and irrotational flow with examples. 3. A fluid flow field is given by $V=x^2yi + y^2zj- (2xyz + yz^2)k$ Prove that it is a case of possible steady incompressible fluid flow. Calculate the velocity and acceleration at the point (2, 1, 3).
CO3	1. Gasoline (specific gravity 0.82) flows at a rate of 215 l/s in upward direction through an inclined venturimeter fitted to a 300 mm diameter pipe. The venturimeter is inclined at 60^o to vertical and its 150 mm diameter throat is 1.2 m from the entrance along its length. Pressure gauges inserted at the inlet and throat show pressures of 0.141 N/mm^2 and 0.077 N/mm^2 respectively. Compute the coefficient of discharge of the venturimeter. If instead of pressure gauges, the entrance and throat are connected to two limbs of a mercury u-tube manometer, determine the manometric reading. 2. A rectangular orifice 1.5 m wide and 1.2 m deep is fitted in one side of a large tank. The water level on one side of the orifice is 2 m above the top edge of the orifice and on the other side the water level is 0.4 m below its top edge. Calculate the discharge through the orifice, if C_d = 0.62. 3. At a point in a pipeline the diameter is 300 mm, the velocity of water is 3 m/sec and the pressure is 420 kN/m^2. At a point 16 m downstream, the diameter gradually reduces to 150 mm. Find the pressure at this point, if the pipe is (i) horizontal (ii) vertical with flow downwards (iii) vertical with flow upwards. 4. A vertical venturimeter 40cm×20cm is provided in a vertical pipeline to measure the flow of oil of relative density 0.8. The difference in elevations of throat section and entrance section is 1 m, the direction of flow of oil being vertically upward. The oil mercury differential gauge shows deflection of mercury equal to 40 cm. Determine the discharge through the pipeline. Neglect losses.

CO4	1. A horizontal pipe line of 40 m long is connected to a water tank at one end and discharges freely into atmosphere at the other end. For the first 25 m of the length from the tank, the pipe is 150 mm diameter and it is suddenly enlarged to 300 mm for the remaining length. The height of water level in the tank is 8 m above the centre line of the pipe. Considering all the losses, find the rate of flow. 2. A 250 mm diameter 3 km long straight pipe runs between two reservoirs of surface elevations 135 m and 60 m. A 1.5 km long, 300 mm diameter pipe is laid parallel to the 250 pipe from its midpoint to the lower reservoir. Neglecting all minor losses and assuming a friction factor of 0.02 for both pipes, compute the increase in discharge resulted by the addition of new pipe. 3. A piping system consists of three pipes arranged in series: the lengths of the pipes are 1200 m; 750 m and 600 m and diameters 750 mm, 600 mm and 450 mm respectively. Transform the system to (i) an equivalent pipe of 450 mm diameter (ii) an equivalent pipe of 2250 m long. 4. A 60^o bend carries a discharge of 360 l/sec. Its inlet diameter is 300 mm and outlet diameter is 150 mm. The pressure at inlet is 2.943 bar. The friction loss in the pipe bend is 10 % of the kinetic energy at the exit of the bend. Determine the force exerted by the bend.
CO5	1. A rectangular channel 1.3 m wide has a rectangular weir built across it. If the length of the weir is 1.1 m and its sill is 0.3 m from the bed. Find the discharge when the head is 0.3. Take C_d=0.65. Use Francis formula. Consider velocity of approach and end contraction. 2. A 40 m long weir is divided into 12 equal bays by vertical posts, each 0.6 m wide. Using Francis formula, calculate the discharge over the weir if the head over the crest is 1.2 m and velocity of approach is 2 m/sec 3. Water flows over a rectangular weir 1 m wide and at a depth of 150 mm and afterwards passes through a triangular right-angled weir. Taking C_d for the rectangular and triangular weir as 0.62 and 0.59, respectively, find the depth over the triangular weir.
CO6	Determine the hydraulic co-efficient of the given orifice.
CO7	Calibrate the given hydraulic device used for measuring discharge in a pipe/channel and determine the discharge corresponding to a particular head.

24CEJ404	TRANSPORTATION ENGINEERING	L	T	P	J	S	C	Year of Introduction
		2	0	2	2	5	5	2024

Preamble: This course covers assessment of highway materials, construction of pavements, design of pavement mixes, study of traffic characteristics, surveys, signal design, and highway operations, along with geometric highway design and fundamental concepts of airport engineering. This course equips students with the knowledge and skills to assess highway materials, construct pavements following codal specifications, and design pavement mixes to industry standards. By the end of this course, students will be well-prepared for a successful career in transportation engineering.

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

CO1	Use codal specifications in judging the quality of highway materials and the construction of various types of pavements. (Understand and apply level)
CO2	Apply standard code specifications in designing mixes and pavement. (Apply level)
CO3	Interpret the basics of traffic characteristics, traffic surveys, signal design and traffic operations of roads and Highways. (Understand and apply level)
CO4	Design the geometric features of Highways. (Apply level)
CO5	Discuss the basics of airport engineering and design airport elements. (Remember and understand level)
CO6	Demonstrate engineering principles to develop designs for traffic signal systems and pavement systems. (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	2	-	2	3	3	-	-
CO2	3	2	1	-	-	2	-	2	3	3	-	-
CO3	3	2	1	-	-	-	-	2	3	3	-	-
CO4	3	3	2	-	2	2	-	2	3	3	-	2
CO5	1	1	1	-	-	-	-	-	-	-	-	-
CO6	3	3	2	-	2	2	-	2	3	3	-	2

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember		✓	✓	✓
Understand		✓	✓	✓
Apply		✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create			✓	

Assessment Pattern for Lab component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1

Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create		

Assessment Pattern for Project component			
Bloom's Category	**Continuous Assessment Tools**		
	Evaluation 1	**Evaluation 2**	**Report**
Remember			
Understand	✓	✓	
Apply	✓	✓	
Analyse	✓	✓	
Evaluate		✓	
Create		✓	

Mark Distribution of CIA

Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**		**Practical [P]**	**Project [J]**			**Total Marks**
		Assignment	**Test-2**	**Class work**	**Evaluation 1**	**Evalaution-2**	**Report**	
2-0-2-2	**5**	**10**	**15**	**10**	**5**	**10**	**5**	**60**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	**60**	**40**	**2**

End Semester Examination [ESE]: Pattern

PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 2.5 hours	40

	Total Marks: 0	Total Marks: [5×8 = 40 marks]	

SYLLABUS
MODULE I (Highway materials)
Introduction to Transportation Engineering, Classification of roads, Typical cross sections of roads in urban and rural areas, Requirements and factors controlling the alignment of roads. Introduction to highway materials, Desirable properties, and testing of road aggregates, bituminous materials, and subgrade soil. **Practical**: Testing of aggregates, bitumen, subgrade soil, DCP. **Project**: Quantity estimation of pavement materials.
MODULE II (Pavement design)
Introduction to geometric design of highways, Objectives, and requirements of safe highway geometric design, Factors governing geometric design (design speed, topography, vehicle, human, environmental, traffic economy, others), Design controls and criteria. Introduction of flexible and rigid pavements - components. Factors influencing the design of flexible pavements, Design of flexible pavements by CBR method and IRC 37: 2018. Construction of bituminous pavements. (Introduction only) **Practical**: Pavement design, Mix design and MERLIN.
MODULE III (Traffic Engineering)
Introduction to traffic engineering, Traffic characteristics, Capacity and Level of Service (Introduction only), Design Speed, Traffic surveys, Types of road intersections. Traffic control devices (Introduction only), and Design of isolated signals by Webster's method. **Practical**: Fundamental traffic flow diagrams, Speed and volume studies. **Project**: Signal Design.
MODULE IV (Geometric design of Highways)
Highway cross-section elements, Design of horizontal alignment - Stopping sight distance, Overtaking sight distance, super elevation, transition curve, extra widening, Vertical alignment (Introduction only). **Project**: Check for geometric consistency.
MODULE V (Airport Engineering)
Introduction to Airport Engineering, Components of airport, selection of site for airport. Runway orientation, basic runway length and corrections required.
Text books **1.** Khanna, S. K. and Justo, C. E. G., Highway Engineering, Nem Chand & Bros., 2015. **2.** Kadiyali, L. R., Traffic Engineering and Transport planning, Khanna Publishers, 1999.
Reference books **1.** Kadiyali, L. R. and Lal, N. B. Principles and Practices of Highway Engineering, Khanna Publishers, 2013

2. Rao G. V., Principles of Transportation and Highway Engineering, Tata McGraw Hill, 1996.
3. Roger P. Roess, Elena S. Prassas and William R. McShane, Traffic Engineering, Pearson, 2019.
4. Rangwala, S. C., Airport Engineering, Charotar Publishing Co., 2016.
5. Khanna, S. K. and Arora. M. G., Airport Planning and Design, Nem chand& Bros.
6. IRC: 37-2018 – Guidelines for the design of flexible pavements.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (24)
	MODULE I (4 Hours)	
1.1	Introduction to Transportation Engineering, Classification of roads, Typical cross sections of roads in urban and rural areas. Requirements and factors controlling the alignment of roads.	1
1.2	Introduction to highway materials, Desirable properties and testing of road aggregates.	1
1.3	Desirable properties and testing of subgrade soil.	1
1.4	Desirable properties and testing of bituminous materials.	1
	MODULE II (6 Hours)	
2.1	Introduction to geometric design of highways, Objectives, and requirements of safe highway geometric design.	1
2.2	Factors governing geometric design (design speed, topography, vehicle, human, environmental, traffic economy, others), Design controls and criteria.	1
2.3	Introduction of flexible and rigid pavements - components. Factors influencing the design of flexible pavements.	1
2.4	Design of flexible pavements by CBR method.	1
2.5	Design of flexible pavements by IRC 37: 2018.	1
2.6	Construction of bituminous pavements. (Introduction only)	1
	MODULE III (5 Hours)	
3.1	Introduction to traffic engineering, Traffic characteristics, Capacity and Level of Service (Introduction only), Design Speed.	1
3.2	Traffic surveys, Types of road intersections.	1
3.3	Traffic control devices. (Introduction only)	1
3.4	Design of isolated signals by Webster's method.	1
3.5	Design of isolated signals by Webster's method.	1
	MODULE IV (5 Hours)	
4.1	Highway cross-section elements.	1

4.2	Design of horizontal alignment - Stopping sight distance.	1
4.3	Design of horizontal alignment- Overtaking sight distance.	1
4.4	Design of super elevation and extra widening.	1
4.5	Transition curve, Vertical alignment. (Introduction only)	1
MODULE V (4 Hours)		
5.1	Introduction to Airport Engineering, Components of airport, selection of site for airport.	1
5.2	Runway orientation.	1
5.3	Basic runway length and corrections required.	1
5.4	Basic runway length and corrections required.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours [24]	Experiment
1	Laboratory test on aggregates	2	1. a) Aggregate crushing value b) Aggregate impact value
		2	2. a) Shape test
		2	3. a) Angularity of coarse and fine aggregate b)Specific gravity and water absorption of coarse aggregate
2	Laboratory test on bitumen	2	1. a) Penetration value of bitumen b) Softening point of bitumen
		2	2. a) Ductility of bitumen b) Mixing and compaction temperature of bitumen
3	Test on subgrade soil	2	1. a) California Bearing Ratio Test b) Dynamic Cone Penetration Test
4	Test on Bituminous Mixes	2	1. a) Theoretical specific gravity of loose mix b) Bulk specific gravity of compacted mix

5	Functional evaluation of pavement	2	1. MERLIN – Road roughness
6	Traffic Surveys	2	1. a) Volume count
		2	2. a) Spot speed study b) Fundamental traffic flow diagrams
7	Lab Exam	2	Odd Batch
		2	Even Batch

COURSE PROJECT

Sample project topics for students to work on:

1	Design the signal timings for an unsignalized intersection or redesign the timings of an existing signalized intersection.
2	Estimate the quantity requirements of pavement materials for a given road stretch based on data available from drawings.
3	Check the geometric consistency of a given road stretch in accordance with codal provisions.

Note: - Projects need not be restricted to the above topics. Students are encouraged to choose any application problems, in the course domain, which they desire to work on.

LESSON PLAN FOR PROJECT COMPONENT

No.	Topic	No. of Class Hours [24]
1	Preliminary Design of the Project	4
2	Zeroth presentation (4th week)	2
3	Project work - First Phase	4
4	Interim Presentation (7th and 8th weeks)	4
5	Project work - Final Phase & Report writing (discussions in class during project hours)	6
6	Final Evaluation and Presentation (11th and 12th weeks)	4

CO Assessment Questions	
1	1. Enumerate the essential properties of aggregates suitable for use in pavement construction. Explain any two laboratory tests conducted to ensure quality of aggregates. 2. Illustrate the cross-section of a National Highway. 3. Discuss the factors controlling the fixation of alignment of roads.
2	1. Explain the factors influencing the design of flexible pavements. 2. State the IRC recommendation of CBR method of design.

	3. Differentiate flexible pavement and rigid pavement. 4. Design a flexible pavement for the construction of a new highway with the following data: Category of road - four lane dual carriage way, number of commercial vehicles in the year of completion of construction = 2400 CVPD per direction, design life = 15year, annual growth rate of vehicles = 5%, design CBR value of soil sub grade = 5%, vehicle damage factor = 3.5 lane distribution factor = 0.75. (Use IRC design Charts)
3	1. Explain the relationship among the variables in a traffic flow with the help of figures. 2. Define Passenger Car Unit (PCU). Point out the PCU values of the different categories of vehicles as per latest IRC guidelines. 3. Elaborate on the different classifications of road intersections and use sketches to illustrate each one. 4. The average normal flow of traffic on cross roads 1 & 2 during design period are 400 and 250 PCU per hour, the saturation flow on these roads is 1250 and 1000 PCU per hour respectively. The all-red time required for pedestrian crossing is 12 s. Design a two-phase traffic signal with pedestrian crossing by Websters method according to Indian Practice.
4	1. A car is moving with a speed of 80 kmph on a highway at a descending gradient of 4 %. If coefficient of friction between the road surface and the tyres is 0.35, calculate the required minimum stopping sight distance. 2. The speed of overtaking and overtaken vehicles is 80 kmph and 60 kmph respectively on a two-way traffic road. If the acceleration of the overtaking vehicle is 0.9 m/sec, calculate the safe overtaking sight distance. 3. Derive an equation for equilibrium super elevation. Determine the super elevation required for a horizontal curve of radius 250 m with a design speed of 70 kmph under mixed traffic condition in an urban area.
5	1. Explain the different patterns of Runway with the help of neat sketches. 2. Explain the orientation of runway using wind rose diagrams. Mention the factors that influence the change in the orientation of runways. 3. Calculate the actual length of runway from the following data: Airport reference temperature = 30 ^{o}C Basic runway length = 630 m Highest and lowest point along the length = R.L 108.4, R.L 106, respectively Airport elevation = R.L 110.
6	1. Estimate the quantity of materials required to construct a pavement structure by visiting a road stretch under construction. 2. Develop a traffic signal solution for an unsignalized intersection facing peak - hour traffic delays by conducting surveys in accordance with established guidelines.

24HUT410	DISASTER MANAGEMENT AND RESILIENT INFRASTRUCTURE	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The aim of this course is to understand the fundamental concepts of hazards and disaster management. The course covers techniques for disaster risk management, the various disaster management policies and introduced the concept of resilient infrastructure. After the completion of course, students will be able to identify and understand the key considerations for design of resilient structures.

Prerequisite: Nil

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

CO1	Define various terminologies in disaster management, hazard types, vulnerability types and do vulnerability assessment. (Remember level)
CO2	Identify the components and describe the process of risk assessment and apply appropriate methodologies to assess risk. (Understand level)
CO3	Explain the core elements and phases of disaster risk management and develop possible measures to reduce disaster risks across sector and community. (Understand level)
CO4	Explain the various legislations and best practices for disaster management and risk reduction at national and international levels. (Understand level)
CO5	Explain design considerations for disaster resilient structure. (Understand level)
CO6	Demonstrate the effectiveness of disaster resilient projects through case studies. (Analyse level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	3	-	-	-	-	-
CO2	2	-	-	-	-	-	3	-	-	-	-	-
CO3	2	-	-	-	-	2	3	-	-	-	-	-
CO4	2	-	-	-	-	3	3	-	-	-	-	-
CO5	2	-	-	-	-	-	3	-	-	-	-	-
CO6	2	-	-	-	-	-	3	-	3	3	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Fundamental concepts of Hazards and Disasters)

Definitions and meaning of key terms in Disaster Risk Reduction and Management - disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment.

Hazard types and hazard mapping: Vulnerability types and their assessment - physical, social, economic and environmental vulnerability.

Disaster risk assessment - approaches, procedure.

MODULE II (Disaster Risk Management)
Disaster risk management - Core elements and phases of Disaster Risk Management. Measures for Disaster Risk Reduction - prevention, mitigation, preparedness. Disaster response - objectives, requirements, response planning, types of responses. Relief - International relief organizations. Participatory stakeholder engagement, Disaster communication - importance, methods, barriers, Crisis counselling.
MODULE III (Disaster Management Policies)
Common disaster types in India, Legislations in India on disaster management, National disaster management policy, Institutional arrangements for disaster management in India. The Sendai Framework for Disaster Risk Reduction - targets, priorities for action, guiding principles. Concept of infrastructure resilience - Capacity Building Concept - Structural and nonstructural measures, Capacity Assessment, strengthening capacity for reducing risk.
MODULE IV (Seismic Design Considerations)
Seismic design considerations – Architectural considerations - Strong column weak beam concept - Concept of shear walls – Diagonal bracings – Base isolation – Dampers etc. Retrofitting existing infrastructure for disaster resilience- Retrofitting of RC and Masonry buildings. Case studies on resilient infrastructure projects.
MODULE V (Flood Resistant Technologies)
Flood resistant design and climate change adaptation - Enhancing Climate Resilience with Flood Resistant Architecture- Flood Barriers and Gates - Floating structures – Amphibious structures - Elevated Foundations – Flood Resistant Materials. Floods-types, Urban flood and its control-best management practices; River behavior, River training and Flood control structures-types. Case studies on flood control and flood resilient infrastructure projects.
Text books 1. R. Subramanian, Disaster Management, Vikas Publishing House, 2018. 2. M. M. Sulphey, Disaster Management, PHI Learning, 2016. 3. UNDP, Disaster Risk Management Training Manual, 2016. 4. United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster Risk Reduction 2015-2030, 2015. 5. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, PHI Learning, 2006. 6. P. N. Modi, Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors, New Delhi, 2009.

Reference books

1. George Haddow, Jane Bullock, and Damon Coppola, "Introduction to Emergency Management".
2. "Disaster Resilience: A National Imperative" by the National Academies Press.
3. Relevant research papers, government reports, and case studies.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (35)
	MODULE 1 (7 Hours)	
1.1	Definitions and meaning of key terms in Disaster Risk Reduction and Management - disaster, hazard.	1
1.2	Exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems.	1
1.3	Disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment.	1
1.4	Hazard types and hazard mapping: Vulnerability types and their assessment - physical, social, economic and environmental vulnerability.	1
1.5	Economic and environmental vulnerability, Core elements of disaster risk assessment.	1
1.6	Components of a comprehensive disaster preparedness strategy approaches, procedures.	1
1.7	Different disaster response actions.	1
	MODULE II (7 Hours)	
2.1	Disaster risk management - Core elements of Disaster Risk Management.	1
2.2	Phases of Disaster Risk Management. Measures for Disaster Risk Reduction.	1
2.3	Measures for Disaster Prevention, mitigation, preparedness.	1
2.4	Disaster response - objectives, requirements, response planning, types of responses.	1
2.5	Introduction to Disaster Relief - International relief organizations.	1
2.6	Participatory stakeholder engagement.	1
2.7	Disaster communication - importance, methods, barriers, Crisis counselling.	1

MODULE III (7 Hours)		
3.1	Introduction to common disaster types in India	1
3.2	Common disaster legislation in India on disaster management.	1
3.3	National disaster management policy, Institutional arrangements for disaster management in India.	1
3.4	The Sendai Framework for Disaster Risk Reduction - targets, priorities for action, guiding principles.	1
3.5	Concept of infrastructure resilience.	1
3.6	Introduction to Capacity Building Concept - Structural and nonstructural measures.	1
3.7	Introduction to Capacity Assessment, strengthening capacity for reducing risk.	1
MODULE IV (7 Hours)		
4.1	Seismic design considerations – Architectural considerations.	1
4.2	Strong column weak beam concept - Concept of shear walls.	1
4.3	Diagonal bracings – Base isolation – Dampers.	1
4.4	Retrofitting existing infrastructure for disaster resilience- Retrofitting of RC and Masonry buildings.	1
4.5	Case studies on resilient infrastructure projects – Presentation by students.	1
4.6	Case studies on resilient infrastructure projects – Presentation by students.	1
4.7	Case studies on resilient infrastructure projects – Presentation by students.	1
MODULE V (7 Hours)		
5.1	Flood resistant design and climate change adaptation Enhancing Climate Resilience with Flood Resistant Architecture.	1
5.2	Flood Barriers and Gates - floating structures - Amphibious structures - Elevated Foundations – Flood Resistant Materials.	1
5.3	Floods - types, Urban flood and its control - best management practices.	1
5.4	River behavior, River training and Flood control structures – types.	1

5.5	Case studies on resilient infrastructure projects – Presentation by students.	1
5.6	Case studies on resilient infrastructure projects – Presentation by students.	1
5.7	Case studies on resilient infrastructure projects – Presentation by students.	1

CO Assessment Questions	
CO1	1. Explain with examples the difference between hazard and risk in the context of disaster management. 2. Explain the following terms in the context of disaster management (a)exposure (b) resilience (c) disaster risk management (d) early warning signs. 3. Explain the types of vulnerability and the approaches to assess them.
CO2	1. List the strategies for disaster risk management before, during and after a disaster. 2. Discuss disaster preparedness? Explain the components of a comprehensive disaster preparedness strategy.
CO3	1. Describe disaster prevention? Distinguish it from disaster mitigation giving examples. 2. Explain the steps for effective disaster communication and discuss the barriers to communication?
CO4	1. Explain the salient features of the National Policy on Disaster Management in India. 2. Explain the guiding principles and priorities of action according to the Sendai Framework for Disaster Risk Reduction.
CO5	1. Explain the different architectural features that affect buildings during earthquakes with neat sketches. 2. Explain the various retrofitting techniques for RC buildings.

24MCT406	ENVIRONMENTAL SCIENCES	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	1	2024

Preamble: Environmental Sciences is a specialized course designed to provide engineering students with a solid foundation in environmental principles and their application to engineering practice. The course aims to enhance students' understanding of the environmental challenges associated with engineering activities and equip them with the knowledge and skills to integrate environmental considerations into their future engineering work. After the completion of the course, the students will be able to understand and evaluate the qualities and treatment methods for various environmental aspects.

Prerequisite: Nil

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

CO1	Identify ecosystem components and threats (Apply level)
CO2	Describe the air and noise pollution problems and their sustainable solutions (Understand level)
CO3	Discuss the water and wastewater qualities and its treatment (Understand level)
CO4	Explain the various types of solid waste and its management strategies (Understand level)
CO5	Associate causes and effects of climate change and suggest climate actions (Evaluate level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	-	-	-	-	3	-	-	2	-	3
CO2	3	-	-	-	-	3	2	-	-	-	-	-
CO3	3	-	-	-	-	3	2	-	-	-	-	-
CO4	2	-	-	-	-	2	1	-	-	-	-	-
CO5	3	3	-	2	-	2	2	-	-	2	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate			✓	
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Environment and Ecosystem)

Introduction - Definition and scope of environmental science - Interdisciplinary nature of the field.

Ecosystem structure and function - Biodiversity and its importance - Threats to biodiversity (habitat loss, invasive species, overexploitation) - Man and Environment – Health and Environment – Environmental Ethics.

Sustainable development – Social, economic and environmental dimensions - Need for Sustainable development, Sustainable Development Goals (SDGs).

MODULE II (Air and Noise pollution)

Air pollutants – classification, sources and impacts - Clean air act and national

ambient air quality standards (NAAQS) - Air quality index - Emission reduction strategies - Understanding and controlling indoor air pollution.
Ground level ozone and photochemical smog - Ozone layer depletion and the Montreal Protocol, Global warming.
Noise Pollution: Sources and effects of noise; quantification of noise pollution (Leq, LAeq, etc.); Control and regulation rules in India.

MODULE III (Water and Wastewater)

Sources and availability of freshwater - Water conservation strategies - Water pollution and its impacts – Water Quality Standards (IS 10500) - Water quality index; Overview of water treatment plant - Sustainable water use and conflicts over water resources.
Wastewater sources and quality – wastewater disposal – Oxygen sag curve - Applicable wastewater discharge standards and typical flow schemes for sewage treatment plant – Decentralized wastewater treatment - natural methods of wastewater treatment.

MODULE IV (Solid and Hazardous Waste Management)

Waste Management: Consumerism and our throw-away culture; Characteristics of municipal solid waste; CPHEEO guidelines for solid waste management (overview only); Waste disposal methods (landfill, incineration, recycling).
Sustainable practices in waste management - Transition to zero waste lifestyle – Circular Economy.
Hazardous and e-waste identification and management - Recycling and waste-to-energy technologies – regulations for hazardous waste management in India (overview only); Biomedical waste and its management.

MODULE V (Climate Action)

Climate Change: Evidence, causes and effects, Carbon footprint, Global warming potential; Role of IPCC in the understanding of climate change; Global climate agreements – The United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement.
Mitigation strategies – carbon capture, utilization, and storage; adapting to climate change.
Renewable Energy - solar energy, Biomass, Wind energy, New Energy sources.

Text books

1. Gilbert M. Masters, Wendell P. Ela, Introduction to Environmental Engineering and Science, 3rd Edition (2013), Pearson Education.
2. Mark Brusseau, Ian Pepper, Charles Gerba, Environmental and Pollution Science, 3rd Edition (2019), Elsevier.
3. Mackenzie L. Davis, Introduction to Environmental Engineering, 5th Edition (2012), McGraw hill Education (India).

Reference books

1. Robert A Corbett, Standard Handbook of Environmental Engineering, 2nd

edition (1999), McGraw Hill.
2. B.C Punmia, Wastewater Engineering, 2nd edition (1998), Laxmi Publications Pvt. Ltd.
3. Mackenzie Davis and Susan Masten, Principles of Environmental Engineering & Science, 4th Edition (2004), McGraw Hill.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE 1 (5 hours)	
1.1	Introduction- Definition and scope of environmental science - Interdisciplinary nature of the field.	1
1.2	Ecosystem structure and function- Biodiversity and its importance.	1
1.3	Threats to biodiversity. (habitat loss, invasive species, overexploitation)	1
1.4	Man and Environment – Health and Environment – Environmental Ethics.	1
1.5	Sustainable development – Social, economic and environmental dimensions – Need for Sustainable development, Sustainable Development Goals (SDGs).	1
	MODULE II (7 hours)	
2.1	Air pollutants – classification, sources and impacts.	1
2.2	Clean air act and national ambient air quality standards (NAAQS) - Air quality index.	1
2.3	Emission reduction strategies - Understanding and improving indoor air quality.	1
2.4	Ground level ozone and photochemical smog.	1
2.5	Ozone layer depletion and the Montreal Protocol, Global warming.	1
2.6	Noise Pollution: Sources and effects of noise; quantification of noise pollution (Leq, LAeq, etc.).	1
2.7	Control and regulation rules in India.	1
	MODULE III (9 hours)	
3.1	Sources and availability of freshwater - Water conservation strategies.	1
3.2	Water pollution and its impacts – Water Quality Standards. (IS 10500)	1
3.3	Water quality index; Overview of water treatment plant.	1

3.4	Sustainable water use and conflicts over water resources.	1
3.5	Wastewater sources and quality.	1
3.6	Wastewater disposal – Oxygen sag curve.	1
3.7	Applicable wastewater discharge standards and typical flow schemes for sewage treatment plant.	1
3.8	Decentralized wastewater treatment.	1
3.9	Natural methods of wastewater treatment.	1
MODULE IV (7 hours)		
4.1	Waste Management: Consumerism and our throw-away culture.	1
4.2	Characteristics of municipal solid waste; CPHEEO guidelines for solid waste management (overview only);	1
4.3	Waste disposal methods. (landfill, incineration, recycling)	1
4.4	Sustainable practices in waste management - Transition to zero waste lifestyle – Circular Economy.	1
4.5	Hazardous and e-waste identification and management – Recycling.	1
4.6	Waste-to-energy technologies – regulations for hazardous waste management in India. (overview only)	1
4.7	Biomedical waste and its management.	1
MODULE V (8 hours)		
5.1	Climate Change: Evidence, causes and effects, Carbon footprint, Global warming potential.	1
5.2	Role of IPCC in the understanding of climate change.	1
5.3	Global climate agreements – The United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement.	1
5.4	Mitigation strategies – carbon capture, utilization and storage.	1
5.5	Adapting to climate change.	1
5.6	Renewable Energy- Solar energy.	1
5.7	Biomass, Wind energy.	1

5.8	New Energy sources.	1

CO Assessment Questions	
CO1	1. Visit any wetland ecosystem and identify the major threats faced. 2. Explain how mangroves aid in coastal protection.
CO2	1. Discuss the sources and effects of CO pollution. 2. Identify the main factors in indoor air quality. 3. Explain the impacts of global warming. 4. Discuss the control measures for noise pollution.
CO3	1. List and explain any three water conservation strategies. 2. Describe the impacts of wastewater discharge to inland water bodies. 3. With a neat layout, explain the treatment units in a conventional water treatment plant. 4. Write short note on natural methods for wastewater treatment.
CO4	1. Explain the concept of circular economy. How does it help in achieving zero waste? 2. Discuss the management strategies for biomedical waste. 3. Classify solid waste based on source. 4. Write a short note on Landfills. 5. Discuss the e-waste management regulations in India.
CO5	1. Estimate the carbon footprint of a brick kiln and suggest appropriate climate action. 2. Suggest appropriate mitigation strategies for pollution from transportation sector.

24CET407	CONSTRUCTION TECHNOLOGY	L	T	P	J	S	C	Year of Introduction
		2	0	0	0	2	2	2024

Preamble: The objective of the course is to enable the students to familiarise with the fundamental concepts of building construction, and advanced technologies used in construction. The course provides a detailed insight into the various building elements, construction technology, and structural systems. After the course, the students will be familiar with the fundamental concepts of building construction.

Prerequisite: 24EST302 Material Science and Engineering

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

CO 1	Recall the construction details of elements of building construction and temporary supporting structures (Remember level)
CO 2	Explain the building service and vertical transportation systems used in buildings (Understand level)
CO 3	Outline the various technologies used for the construction (Remember level)
CO 4	Explain the structural systems and summarise the causes of building failures (Understand level)
CO 5	Explain the methods for the protection of buildings and retrofitting techniques of structural components (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	3	-	-	-	-	-	-
CO 2	3	-	-	-	-	2	-	-	-	-	-	-
CO 3	2	-	-	-	-	2	3	-	-	-	-	-
CO 4	2	-	-	-	-	2	-	-	-	-	-	-
CO 5	2	-	-	-	-	2	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	-
Understand	✓	✓	✓	-
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
2-0-0-0	5	35	30	30	**100**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	-	-

End Semester Examination [ESE]: Pattern: There is no ESE for this course.

SYLLABUS

MODULE I (Building Construction I)

Building Construction: Types of buildings, selection of site for buildings, components of a residential building and their functions, Setting out of building.

Foundations: Bearing capacity of soil (definition only), functions of foundations, types – shallow and deep. (brief description only)

Masonry: Terms used, types of masonry (brick and stone), Bond - types – Header bond, stretcher bond, English bond & Flemish bond, Plan and elevation of English and Flemish bond (one brick thick wall only), Load bearing walls, Partition walls.

Lintels and arches: Types and construction details.

MODULE II (Building Construction II)

Doors, windows and ventilators: Types and construction details.

Roofs: Functions, types, suitability, roofing materials. (brief description only)

Floors: Functions, flooring materials. (brief description only)

Finishing works: Plastering, pointing, painting – objectives and types.

Temporary Supporting Structures: Formwork - requirements of good formwork, classification, materials for formwork, formwork design (concept only), de-shuttering of formwork, slip form construction, Scaffolding - uses and classification (brief discussion only), shoring, underpinning.

MODULE III (Building Services and Vertical Transportation Systems)

Building services: Essential services such as plumbing, water supply, drainage of wastewater and sewage, electrical supply, Special services such as HVAC, thermal insulation, acoustics and sound insulation, fire safety for buildings. (brief description only)

Vertical transportation systems: Stairs – types - layout and planning, Elevators – types – terminology – passenger, service and goods elevators – handling capacity - arrangement and positioning of lifts, Escalators – features, types, Ramps - use of ramps.

MODULE IV (Construction Technology)

Cost-effective construction: Rapid wall construction, soil-cement block masonry, voided slab, technology, filler slab technology, rat-trap bond masonry. (brief discussion only)

Prefabricated construction: Advantages and disadvantages, prefabricated components.

Introduction to Pre-engineered buildings.

Basic concept of prestressing: Fundamental understanding of pre-tensioned and post-tensioned construction.

Construction 3D printing. (brief discussion only)

Green buildings: Materials, energy systems, water management and environment for green buildings, LEED and GRIHA rating. (brief description only)

MODULE V (Structural Systems and Building Protection)

Structural systems: Load bearing and framed construction, RCC and steel framed structures - erection of steel work – concrete framed construction – construction and expansion joints.

Building failures: General reasons of building failure, Causes of failures in RCC, steel and masonry structures.

Protection of Buildings: Anti-termite treatment (termites, principles, methods), Damp prevention – Sources of dampness, effects of dampness, methods of damp-proofing, damp proof course, Water proofing – methods, Fire protection, Protection from lightning, Earthquake resistant construction – Construction aspects only.

Retrofitting: Retrofitting of structural components such as beam, column and slab.

Text books

1) Varghese P. C. (2007), Building Construction, Prentice Hall India.
2) Punmia B. C., Ashok Kumar Jain and Arun Kumar Jain (2016), Building Construction, Laxmi Publications (P) Ltd.
3) Arora and Bindra, Building construction, Dhanpath Rai and Sons.

Reference books

1) Sahu G. C. and Joygopal Jena (2015), Building Materials and Construction, McGraw Hill Education (India) Private Limited.
2) Gambhir M. L. (2004), Concrete Technology, Tata McGraw-Hill Publishing Company Limited.
3) Tony Bryan (2010), Construction Technology – Analysis and Choice, Wiley-Blackwell.
4) Chen W. F. and Liew J. Y. R. (Eds), The Civil Engineering Handbook. II Edition, CRC Press. (Taylor and Francis)
5) Chudley R. and Greeno R., Building construction handbook, Addison Wesley, Longman group, England.
6) Chudley R, Construction Technology, Vol. I to IV, Longman group, England Course Plan.
7) Rangwala S. C. and Dalal K. B., Building Construction, Charotar Publishing house.
8) Huntington W. C., Building Construction, John Wiley Publications.
9) Purushothama Raj P. (2016), Building Construction Materials and Techniques, Pearson India.
10) Remith R. and Jais Joy (2017), Construction Technology, Raveendra

Publishers, Trissur.
11) Sankara Subramaniyan V. (2017), Construction Technology, Lakshmi Publications, Chennai.
12) Bhavikatti S. S. (2017), Construction Technology, Chess Educational Publishers, Chennai.
13) Madan Mehta, Walter Scarborough, Diane Armpriest (2017), Building Construction: Principles, Materials, Systems, Pearson India.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (24)
	MODULE 1 (6 Hours)	
1.1	Building Construction: Types of buildings, selection of site for buildings.	1
1.2	Components of a residential building and their functions, Setting out of building.	1
1.3	Foundations: Bearing capacity of soil (definition only), functions of foundations, types – shallow and deep. (brief description only)	1
1.4	Masonry: Terms used, types of masonry (brick and stone), Bond - types – Header bond, stretcher bond, English bond & Flemish bond, Plan and elevation of English and Flemish bond. (one brick thick wall only)	1
1.5	Load bearing walls, Partition walls.	1
1.6	Lintels and arches: Types and construction details.	1
	MODULE II (6 Hours)	
2.1	Doors, windows and ventilators: Types and construction details.	1
2.2	Roofs: Functions, types, suitability, roofing materials. (brief description only)	1
2.3	Floors: Functions, flooring materials. (brief description only)	1
2.4	Finishing works: Plastering, pointing, painting – objectives and types.	1
2.5	Temporary Supporting Structures: Formwork - requirements of good formwork, classification, materials for formwork, formwork design (concept only), de-shuttering of formwork.	1

2.6	Slip form construction, Scaffolding - uses and classification (brief discussion only), shoring, underpinning.	1
MODULE III (4 Hours)		
3.1	Building services: Essential services such as plumbing, water supply, drainage of wastewater and sewage, electrical supply.	1
3.2	Special services such as HVAC, thermal insulation, acoustics and sound insulation, fire safety for buildings. (brief description only)	1
3.3	Vertical transportation systems: Stairs – types - layout and planning.	1
3.4	Elevators – types – terminology – passenger, service and goods elevators – handling capacity - arrangement and positioning of lifts, Escalators – features, types, Ramps - use of ramps.	1
MODULE IV (4 Hours)		
4.1	Cost-effective construction: Rapid wall construction, soil-cement block masonry, voided slab, technology, filler slab technology, rat-trap bond masonry. (brief discussion only)	1
4.2	Prefabricated construction: Advantages and disadvantages, prefabricated building components. Introduction to Pre-engineered buildings.	1
4.3	Basic concept of prestressing – Fundamental understanding of pre-tensioned and post-tensioned construction, Construction 3D printing. (brief discussion only)	1
4.4	Green buildings: Materials, energy systems, water management and environment for green buildings, LEED and GRIHA rating. (brief description only)	1
MODULE V (4 Hours)		
5.1	Structural systems: Load bearing and framed construction, RCC and steel framed structures - erection of steel work – concrete framed construction – construction and expansion joints.	1
5.2	Building Failures: General reasons of building failure, Causes of failures in RCC, steel and masonry structures.	1
5.3	Protection of Buildings: Anti-termite treatment (termites, principles, methods), Damp prevention – Sources of dampness, effects of dampness, methods of damp-proofing, damp proof course, Water proofing – methods, Fire protection, Protection from lightning, Earthquake resistant construction –	1

	Construction aspects only.	
5.4	Retrofitting: Retrofitting of structural components such as beam, column and slab.	1

CO Assessment Questions	
CO1	Explain the components of a residential building with the help of a neat sectional elevation.
CO2	Explain the types of stairs with neat sketches.
CO3	List the various cost-effective construction technologies. Explain the principles and advantages of any two.
CO4	Explain the causes of failures in RCC and steel structures.
CO5	Define retrofitting. Explain the retrofitting of columns with neat sketches.

Topics for self-learning: Underwater construction, Cofferdams, Top to bottom construction method, Equipment used in construction, Composite masonry, Cavity walls, Failure of buildings due to fire, wind, cyclones**.**

MINOR & HONOURS COURSES

24CEM409	Climate Change and Sustainability	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: The aim of this course is to educate students about the basic aspects of climate change and its effects, and sustainable practices that can be adopted to reduce carbon emissions. This course covers various aspects of climate change and sustainable measures of mitigation. This course will enable the students to understand and interpret the basics of climate change and its effects, and the sustainable practices that can be adopted.

Prerequisite: Nil

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

CO 1	Explain the changes that have occurred in the climate of earth over the years and analyze the mechanisms. (Understand level)
CO 2	Interpret national and international agreements and standards in accounting greenhouse gases and mitigating climate change. (Understand level)
CO 3	Explain the impacts of climate change on the natural and social environment and demonstrate how it affects the environment, locally and globally. (Understand level)
CO 4	Discuss the various options to mitigate the effects of climate change or adapt to it. (Understand level)
CO 5	Identify sustainable practices which can be implemented in various sectors of development and suggest green solutions. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	2	1	-	-	-	-	-
CO 2	2	-	-	-	-	3	2	-	-	-	-	-
CO 3	3	-	-	-	-	2	2	-	-	-	-	-
CO 4	3	-	-	-	-	3	3	-	-	-	-	-
CO 5	3	-	-	-	-	3	3	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Climate and climate change)

History of Earth's climate system – glacial and interglacial cycles – ice age - Milankovitch cycles, Components of the terrestrial climate system and their interactions, Science of climate change: Drivers of climate change - Greenhouse effect - greenhouse gases, concept of global warming potential (GWP), Aerosols – reflective and black carbon, Energy balance, Albedo effect - Forcings and feedback processes in climate system, radiative forcing, water vapour feedback, Carbon cycle and its role in climate change. Keeling curve - Human induced climate change – Emission scenarios – Shared socio-economic pathways.

MODULE II (International Legal and Policy Frameworks to Address Climate Change)

International climate change negotiations - United Nations Framework Convention on Climate Change (UNFCCC). Gandhian principles in climate change, Kyoto

Protocol - Key commitments by Parties. Evolution of negotiations over the past years- Carbon trading.
Paris agreement – Plans for climate action (NDCs) - Implementation IPCC Assessment Report (latest AR) – summarize working group contributions – deviations from the previous report, models used and new predictions, major links between natural world and human induced actions, mitigation and adaptation recommendations.

MODULE III (Impacts of climate change)

Impact on oceans, coastal regions, sea water intrusion, Impact on polar regions, melting of ice caps, sea level rise. Impact on biodiversity, Impact on agriculture and impacts due to agriculture. Any 2 case studies (water-related) on climate change impacts.

MODULE IV (Mitigation and adaptation strategies in climate change)

Conventional mitigation technologies – Renewable energy, fuel switching, efficiency gains, nuclear power, carbon capture storage and utilization.
Negative emissions technologies – carbon capture and sequestration methods, Carbon dioxide Removal (CDR) methods. Adaptation – Nature based solutions – Climate resilient infrastructure.

MODULE V (Sustainable development)

Sustainable development, SDGs, Sustainable cities and communities – basic aspects. Case study of 2 cities.
Green technologies – Green technologies for sustainable water management, ZLD processes in industries. Sustainable Energy - Energy production from biomass and wastes, energy conservation - green computing.

Text books

1. Dash Sushil Kumar, Climate Change – An Indian Perspective, Cambridge University Press India Pvt. Ltd, 2007.
2. David Archer, The Climate Crisis - An Introductory Guide to Climate Change. (Cambridge University Press 2014; ISBN: 9781107321243)
3. The Royal Society, National Academy of Sciences, Climate Change Evidence and Causes, National Academies Press 2014; ISBN:9780309302029, 0309302021.
4. Steven Earle, A Brief History of the Earth's Climate Everyone's Guide to the Science of Climate Change; New Society Publishers, 2021. ISBN:9781771423489, 177142348X.

Reference books

1. David Archer, Global Warming: Understanding the Forecast, 2nd Ed. (Wiley, 2011; ISBN 978-0-470-94341-0).

2. Jan C. van Dam, Impacts of Climate Change and Climate Variability on Hydrological Regimes, Cambridge University Press, 2003.
3. Roger A. Pielke, Jr., The Climate Fix (Basic Books, 2010; ISBN 978-0-465-02519-0).

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (48)
	MODULE 1 (10 hours)	
1.1	History of Earth's climate system– glacial and interglacial cycles – ice age - Milankovitch cycles.	1
1.2	Milankovitch cycles.	1
1.3	Components of the terrestrial Climate System and their interactions.	1
1.4	Science of Climate Change: Drivers of climate change.	1
1.5	Greenhouse effect - greenhouse gases and their mechanism.	1
1.6	Concept of global warming potential (GWP).	1
1.7	Aerosols – reflective and black carbon, Energy balance, Albedo effect - Forcings and feedback processes in climate system, radiative forcing, water vapour feedback.	1
1.8	Carbon cycle and its role in climate change.	1
1.9	Keeling curve - Human induced climate change.	1
1.10	Emission scenarios – Shared socio-economic pathways.	1
	MODULE II (10 hours)	
2.1	Brief history of international climate change negotiations - United Nations Framework Convention on Climate Change (UNFCCC).	1
2.2	The key provisions of the UNFCCC, organizational structure.	1
2.3	Different Party groups under the Convention – COPs.	1
2.4	Gandhian principles in climate change.	1
2.5	Kyoto Protocol - Key commitments by Parties. - overview of main negotiation issues.	1

2.6	Evolution of negotiations over the past years (from a two-track to a one-track approach) - Carbon trading.	1
2.7	Paris agreement – Plans for climate action (NDCs) - Implementation.	1
2.8	IPCC Assessment Report (latest AR) – summarize working group contributions.	1
2.9	Deviations from the previous report, models used and new predictions.	1
2.10	Major links between natural world and human induced actions, mitigation and adaptation recommendations.	1
MODULE III (8 hours)		
3.1	Impact on oceans, coastal regions, sea water intrusion.	1
3.2	Impact on sea water intrusion.	1
3.3	Impact on polar regions, melting of ice caps, sea level rise.	1
3.4	Impact on biodiversity.	1
3.5	Impact on agriculture.	1
3.6	Impacts due to agriculture.	1
3.7	Case study-1 (water-related) on climate change impacts.	1
3.8	Case study-2 (water-related) on climate change impacts.	1
MODULE IV (10 hours)		
4.1	Conventional mitigation technologies – Renewable energy, fuel switching.	1
4.2	Efficiency gains, nuclear power.	1
4.3	Carbon capture storage and utilization.	1
4.4	Negative emissions technologies – carbon capture.	1
4.5	Sequestration methods.	1
4.6	Carbon dioxide Removal (CDR) methods.	1
4.7	Adaptation – Nature based solutions.	1

4.8	Climate resilient infrastructure.	1
4.9	Case study 1 – Room for the river project.	1
4.10	Case study 2 – Room for the river project.	1
MODULE V (10 hours)		
5.1	Sustainable development, SDGs.	1
5.2	Sustainable cities and communities –basic aspects.	1
5.3	Case studies city 1.	1
5.4	Case studies city 2.	1
5.5	Green technologies – Green technologies for sustainable water management-1.	1
5.6	Green technologies for sustainable water management-2.	1
5.7	ZLD processes in industries.	1
5.8	Sustainable Energy - Energy production from biomass and Wastes-1.	1
5.9	Sustainable Energy - Energy production from biomass and Wastes-2.	1
5.10	Energy conservation - green computing.	1

CO Assessment Questions	
CO1	“Keeling curve is a warning signal for global warming”. Justify this statement.
CO2	Explain how Paris Agreement can serve as a framework for guiding the global efforts to combat climate change? Discuss in detail, stating the NDCs.
CO3	“Climate change alters the water cycle on our planet”. Discuss the statement, stating the various pathways.
CO4	Identify any two measures by which renewable energy sources can be utilised in farming and livestock sector. Explain how it can be implemented.
CO5	Discuss any four possibilities for sustainable water management in a region like Kerala with long coastal line and high annual average rainfall.

24CEH419	MODERN CONSTRUCTION MATERIALS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: Goal of this course is to expose the students to the recent developments in the modern construction materials, and to introduce the conventional construction materials and their modern use. After this course, students will be able to identify and decide the material most suited for the construction, considering the durability, sustainability and economy in the material selection.

Prerequisite: 24CET407 Construction Technology.

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

CO1	Identify and select suitable concrete type for a specific construction. (Understand level)
CO2	Compare various structural materials for construction. (Understand level)
CO3	Select suitable non-structural materials for buildings. (Understand level)
CO4	Describe sustainable materials for construction. (Remember level)
CO5	Explain various smart materials suitable for structures. (Remember level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2						1					3
CO 2	2						1					3
CO 3	2						1					
CO 4	2						2					
CO 5	2						1					3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test 1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I: (Advanced Concrete)

Concrete - special concretes for specific purposes like lightweight concrete, ready mixed concrete, high strength concrete, high performance concrete, self-compacting concrete, fibre reinforced concrete, polymer concrete, geopolymer concrete, textile reinforced concrete, ferrocement (brief description of composition, properties, and applications of the above).

MODULE II: (Structural Materials)

Bricks, fly ash bricks - Stone; Stabilised mud blocks, soil - cement blocks, calcium silicate bricks, red mud - Wood, Industrial Products which can substitute wood: particle board, fibre board, hard board, Glulam - Polymers; Fibre reinforced polymers - Metals; Steel; Aluminium - Bituminous materials – Glass, glass reinforced gypsum – Plastics - jute fibre polymer composite.

MODULE III: (Non-structural Materials)

Properties and use of conventional and modern waterproofing materials, Conventional and modern insulating materials (thermal, sound and electrical insulating materials). Concept of polymer floor finishes, Paints, tiles, Acoustic Treatment, Dry walls and Anchors.

MODULE IV: (Sustainable Materials)

Sustainable Construction Materials - Wood, bamboo, straw bales, earthen materials, glass cullet, copper slag, municipal incinerated bottom ash, recycled aggregates, recycled plastic products, sustainable concretes, bio composites, thatched roofing, linoleum flooring. Energy - Definition, Types of Unit Energy Values, Assessment of Energy (brief discussion only). Introduction to Life Cycle Assessment (brief discussion only).

MODULE V: (Smart and Intelligent Materials)

Types - Neoprene, Bridge pads, thermocol - Smart and Intelligent Materials, Special features: - Shape Memory Alloys (SMAs), Magneto strictive materials, Piezoelectric materials, Electrochromic materials, Green materials including biomaterials, biopolymers, bioplastics – Case studies showing the applications of smart and intelligent materials.

Text books

1. Building Materials, P. C. Varghese, Prentice-Hall India, 2005.
2. Concrete: Microstructure, properties and materials, P.K. Mehta and P.J.M. Monteiro, McGraw Hill, 2006.
3. Properties of concrete, A.M. Neville, Pearson, 2004.
4. Concrete Technology, Shetty M. S., S. Chand & Co., 2006.
5. Materials Science and Engineering, V. Raghavan, Prentice Hall, 1990.

Reference books

1. Construction materials: Their nature and behaviour, Eds. J.M. Illston and P.L.J. Domone, 3rd ed., Spon Press, 2001.
2. The Science and Technology of Civil Engineering Materials, J.F. Young, S. Mindess, R.J. Gray & A. Bentur, Prentice Hall, 1998.
3. Materials for Civil and Construction Engineers, Michel S. Mamlouk and John P. Zaniewski, Prentice Hall.
4. Building Materials Technology, L. Reed Brantley and Ruth T Brantley, McGraw- Hill Publishers.
5. Civil Engineering Materials, Neil Jackson and Ravindra K. Dhir, Palgrave Foundations.
6. Construction Materials and Processes, Don A. Watson, Career Education.
7. Smart Materials and Structures, Gandhi M. V. and B. S. Thompson, Chapmann & Hall, London.

8. Concrete: Microstructure, properties and materials, P.K. Mehta and P.J.M. Monteiro, McGraw Hill, 2006.
9. Modern Construction Materials, Ganapathy, C., Eswar Press, 2015.
10. Materials for civil and Highway Engineers, Deucher, K.N, Korfiatis, G.P and Ezeldin, A.S, Prentice Hall Inc., 1998.
11. Smart Structure and Materials, Brain Culshaw, Artech House – Borton. London-1996.
12. Sustainable Construction, Sandy Halliday, Butterworth-Heinemann, 2008.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hour 48
	MODULE 1 (9 hours)	
1.1	Review of properties of concrete, uses of concrete.	1
1.2	Lightweight concrete (types, properties and uses).	1
1.3	Ready mixed concrete.	1
1.4	High strength concrete, high performance concrete.	1
1.5	Self-compacting concrete (properties, tests and uses).	1
1.6	Fibre reinforced concrete (properties and applications).	1
1.7	Polymer concrete (types, properties and uses).	1
1.8	Geopolymer concrete (brief description of one part and two part geopolymer concrete, composition, properties, and uses).	1
1.9	Textile reinforced concrete (properties and uses), ferrocement (construction, properties and applications).	1
	MODULE II (10 hours)	
2.1	Bricks, fly ash bricks , light weight concrete/aerated cement concrete block.	1
2.2	Stone; Stabilised mud blocks, soil.	1
2.3	Cement blocks, calcium silicate bricks, red mud.	1
2.4	Wood, Industrial Products which can substitute wood – particle board, fibre board, hard board, Glulam.	1

2.5	Polymers; Fibre reinforced polymers.	1
2.6	Metals – Steel, Aluminium.	1
2.7	Bituminous materials.	1
2.8	Glass, glass reinforced gypsum, Structural glazing, toughened and laminated glass.	1
2.9	Plastics – PVC, UPVC.	1
2.10	Jute fibre polymer composite.	1
MODULE III (9 hours)		
3.1	Properties and use of conventional waterproofing materials.	1
3.2	Properties and use of modern waterproofing materials.	1
3.3	Conventional and modern insulating materials (thermal).	1
3.4	Sound and electrical insulating materials.	1
3.5	Concept of polymer floor finishes.	1
3.6	Paints.	1
3.7	Tiles Acoustic Treatment.	1
3.8	Dry walls.	1
3.9	Anchors.	1
MODULE IV (10 hours)		
4.1	Sustainable Construction Materials - Wood, bamboo, straw bales (characteristics, types and uses).	1
4.2	Earthen materials- rammed earth, earthen bags, mudbrick, adobe, cob, compressed earth block, (characteristics, types and uses).	1
4.3	Earth shelter technique.	1

4.4	Glass cullet, copper slag, municipal incinerated bottom ash. (characteristics and uses)	1
4.5	Recycled aggregates. (characteristics, types and uses)	1
4.6	Recycled plastic products. (characteristics, types and uses)	1
4.7	Sustainable concretes, thatched roofing, linoleum flooring. (characteristics, types and uses)	1
4.8	Energy - Definition, Types of Unit Energy Values.	1
4.9	Assessment of energy.	1
4.10	Introduction to Life Cycle Assessment. (brief discussion)	1
MODULE V (10 hours)		
5.1	Types- Neoprene.	1
5.2	Bridge pads.	1
5.3	Thermocol.	1
5.4	Smart and Intelligent Materials.	1
5.5	Shape Memory Alloys (SMAs), Magnetostrictive Materials.	1
5.6	Piezoelectric Materials, Electrochromic materials.	1
5.7	Green materials including biomaterials.	1
5.8	Biopolymers, bioplastics.	1
5.9	Case studies showing the applications of smart and Intelligent Materials.	1
5.10	Case studies showing the applications of smart and Intelligent Materials.	1

CO Assessment Questions	
CO1	1. Explain the mix composition, properties and uses of high strength concrete.

	2. Describe the properties and uses of fibre reinforced concrete.
CO2	1. Explain the types and properties of structural materials 2. Enumerate the applications of various structural materials in construction
CO3	1. Explain the types and properties of non-structural materials 2. Describe the manufacturing process of various non-structural materials
CO4	1. Enumerate the uses and applications of various sustainable materials in construction 2. Define the concepts of life cycle assessment
CO5	1. Explain the pros and cons of various smart materials 2. Enumerate the applications of smart materials in construction

24CEH429	TRANSPORTATION DATA ANALYSIS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: This course aims to introduce students to fundamental transportation data analysis concepts, fostering the ability to solve diverse transportation engineering issues. By applying statistical principles, students will grasp essential data analysis tools, empowering them to address complex problems within the realm of transportation engineering effectively. Through this exposure, students will develop the skills needed to analyze data and propose solutions for real-world challenges.

Prerequisite: NIL

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

CO1	Develop an understanding of fundamental principles related to traffic engineering (Understand level)
CO2	Apply the concepts of statistical inference for transportation problems (Apply level)
CO3	Demonstrate the proficiency in employing sampling methods to capture representative traffic engineering data effectively (Apply level)
CO4	Illustrate the use of continuous and discrete distribution for transportation problems (Apply level)
CO5	Develop regression models for traffic engineering applications (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	1	1	-	-	-	-	-	-	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-
CO4	2	2	1	1	-	-	-	-	-	-	-	-
CO5	2	2	1	1	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hrs

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE 1 (INTRODUCTION TO TRAFFIC ENGINEERING)

Introduction to Traffic Engineering - Traffic stream characteristics: Road user and vehicle characteristics, Fundamental parameters and relations - space headway, time headway, Capacity and Level of Service concepts.

MODULE 2 (STATISTICAL INFERENCE)
Statistical Inference - Descriptive Statistics - Measures of Relative Standing, Measures of Central Tendency, Measures of Variability, Skewness and Kurtosis - Methods of displaying data - Histograms, Ogives, Box Plots, Scatter Diagrams, Bar and Line Charts - Application of cumulative frequency distribution in traffic engineering - 98th percentile speed, 85th percentile speed and 15th percentile speed.
MODULE 3 (POPULATION AND SAMPLES)
Populations and samples. Sampling distribution of the mean (sigma known and unknown), Sampling distribution of the variance (sigma known and unknown). Interval estimation: - Confidence interval for mean and variance - Relevance of sampling in transportation survey.
MODULE 4 (RANDOM VARIABLES)
Random Variables – discrete and continuous random variables - Standard discrete distributions - Binomial and Poisson distribution. Standard continuous distributions – Exponential and Normal distribution, Mean and variance (derivation is not required) – Use of poisson's distribution and binomial distribution in transportation engineering.
MODULE 5 (LINEAR REGRESSION AND CORRELATION AND TIME SERIES MODEL)
Linear regression and correlation - Assumptions of linear regression model - method of least squares - coefficient of determination - correlation coefficient - Multiple linear regression - Application of regression analysis in traffic engineering – Greenshield Model Time series model - Components of time series - Different types - Application of time series data in traffic engineering. Traffic volume forecasting (Basic concepts only)
Text books 1. Stewart, W. J. (2009). Probability, Markov chains, queues, and simulation: the mathematical basis of performance modeling. 2. Douglas, C. Montgomery, Cheryl L. Jennings, Murat Kulahci (2015), Introduction to Time Series Analysis and Forecasting, Second Edition, John Wiley & Sons. 3. Johnson, R. A., Miller, I., & Freund, J. E. (2000). Probability and statistics for engineers.
Reference books 1. Kadiyali, L. R. (2016). Transportation engineering, Khanna Publishing.

2. Gupta. S. C. and Kapoor. V. K (2020), Fundamentals of Mathematical Statistics, Sultan Chand and Sons.
3. Washington, S., Karlaftis, M. G., Mannering, F., & Anastasopoulos, P. (2020). Statistical and econometric methods for transportation data analysis.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (48 hours)
	MODULE 1 (9 Hours)	
1.1	Introduction to Traffic Engineering - Traffic stream characteristics, Road user and vehicle characteristics.	1
1.2	Introduction to Traffic Engineering - Traffic stream characteristics, Road user and vehicle characteristics.	1
1.3	Fundamental parameters and relations.	1
1.4	Fundamental parameters and relations.	1
1.5	Space headway, time headway.	1
1.6	Space headway, time headway.	1
1.7	Capacity and Level of Service concepts.	1
1.8	Capacity and Level of Service concepts.	1
1.9	Capacity and Level of Service concepts.	1
	MODULE 2 (9 Hours)	
2.1	Statistical Inference - Descriptive Statistics.	1
2.2	Measures of Relative Standing, Measures of Central Tendency.	1
2.3	Measures of Variability, Skewness and Kurtosis.	1
2.4	Methods of displaying data – Histograms.	1
2.5	Ogives, Box Plots.	1
2.6	Scatter Diagrams, Bar and Line Charts.	1
2.7	Application of cumulative frequency distribution in traffic engineering - 98th percentile speed, 85th percentile speed and	1

	15th percentile speed.	
2.8	Application of cumulative frequency distribution in traffic engineering - 98th percentile speed, 85th percentile speed and 15th percentile speed.	1
2.9	Application of cumulative frequency distribution in traffic engineering - 98th percentile speed, 85th percentile speed and 15th percentile speed.	1
MODULE 3 (10 Hours)		
3.1	Populations and samples. Sampling distribution of the mean (sigma known and unknown).	1
3.2	Populations and samples. Sampling distribution of the mean (sigma known and unknown).	1
3.3	Sampling distribution of the variance (sigma known and unknown).	1
3.4	Sampling distribution of the variance (sigma known and unknown).	1
3.5	Interval estimation: Confidence interval for mean and variance.	1
3.6	Interval estimation: Confidence interval for mean and variance.	1
3.7	Interval estimation: Confidence interval for mean and variance.	1
3.8	Relevance of sampling in transportation survey.	1
3.9	Relevance of sampling in transportation survey.	1
3.10	Relevance of sampling in transportation survey.	1
MODULE 4 (10 Hours)		
4.1	Random Variables – discrete and continuous random variables.	1
4.2	Random Variables – discrete and continuous random variables.	1
4.3	Standard discrete distributions - Binomial and Poisson distribution.	1
4.4	Standard discrete distributions - Binomial and Poisson distribution.	1
4.5	Standard continuous distributions – Exponential and Normal distribution, Mean and variance. (derivation is not required)	1

4.6	Standard continuous distributions – Exponential and Normal distribution, Mean and variance. (derivation is not required)	1
4.7	Standard continuous distributions – Exponential and Normal distribution, Mean and variance. (derivation is not required)	1
4.8	Use of Poisson's distribution and Binomial distribution in transportation engineering.	1
4.9	Use of Poisson's distribution and Binomial distribution in transportation engineering.	1
4.10	Use of Poisson's distribution and Binomial distribution in transportation engineering.	1
MODULE 5 (10 Hours)		
5.1	Linear regression and correlation - Assumptions of linear regression model.	1
5.2	Linear regression and correlation - Assumptions of linear regression model.	1
5.3	Method of least squares - coefficient of determination - correlation coefficient - Multiple linear regression.	1
5.4	Method of least squares - coefficient of determination - correlation coefficient - Multiple linear regression.	1
5.5	Application of regression analysis in traffic engineering – Greenshield Model.	1
5.6	Application of regression analysis in traffic engineering – Greenshield Model.	1
5.7	Time series model - Components of time series - Different types.	1
5.8	Time series model - Components of time series - Different types.	1
5.9	Application of time series data in traffic engineering – traffic volume forecasting. (Basic concepts only)	1
5.10	Application of time series data in traffic engineering – traffic volume forecasting. (Basic concepts only)	1

CO Assessment Questions	
CO1	1. Explain how road user and vehicle characteristics impact the characteristics of traffic streams.

<table>
<tr><td>CO2</td><td>
1. Discuss how the 85th percentile speed and the 15th percentile speed, obtained from cumulative frequency distributions, are used in traffic engineering and road design. Provide specific examples of how this information influences decisions related to road safety and speed limit setting.
2. In a recent traffic study conducted on a highway, the speeds of vehicles passing a specific section of the road were recorded. The cumulative frequency distribution for the vehicle speeds is as follows:
<table>
<tr><th>Speed (mph)</th><th>Cumulative Frequency</th></tr>
<tr><td>40</td><td>100</td></tr>
<tr><td>50</td><td>250</td></tr>
<tr><td>60</td><td>500</td></tr>
<tr><td>70</td><td>750</td></tr>
<tr><td>80</td><td>900</td></tr>
<tr><td>90</td><td>950</td></tr>
<tr><td>100</td><td>1000</td></tr>
</table>
Calculate the following traffic statistics based on the cumulative frequency distribution:
1. The 15th percentile speed.
2. The 85th percentile speed.
3. The 98th percentile speed.
</td></tr>
<tr><td>CO3</td><td>
1. Imagine you are conducting a transportation survey to estimate the average commuting time for a city's residents. Describe the process of selecting an appropriate sample size and constructing a confidence interval for the mean commuting time, both when the population standard deviation is known and when it is unknown.
2. You are conducting a transportation survey to estimate the average commuting time for residents in a city. The population of the city is large and diverse. Suppose you want to estimate the mean commuting time with a 95 % confidence level. The population standard deviation is known to be 15 minutes for this problem. Calculate the required sample size (n) needed to estimate the mean commuting time with a margin of error of ± 5 minutes when the population standard deviation is known.
</td></tr>
<tr><td>CO4</td><td>
1. Explain the practical applications of both Poisson's distribution and the Binomial distribution. Provide examples illustrating how these probability distributions are used to model and solve real-world problems related to traffic engineering.
2. In a specific urban area, traffic accidents occur randomly at an average
</td></tr>
</table>

	rate of 3 accidents per day. Calculate the probability that there will be exactly 2 accidents on a randomly chosen day in this urban area using Poisson's distribution.
CO5	1. Consider the following data points representing the relationship between the number of vehicles (x) and the traffic flow (y) on a specific road: x: [10, 15, 20, 25, 30] y: [22, 30, 35, 40, 45] 1. Compute the linear regression equation for this data using the method of least squares. 2. Calculate the coefficient of determination (R-squared) for this linear regression. 3. Determine the correlation coefficient between x and y.

24CEH439	ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble:
The objective of the course is to provide students with basic concepts from environmental chemistry and microbiology for understanding and solving environmental problems. A knowledge of physical and organic chemistry and various instrumental methods for environmental applications will be imparted. The course will combine the fundamentals of microbes, growth kinetics, biodegradability and knowledge of important terminology for biological processes occurring in environmental systems.

Prerequisite: 24CYP103 Engineering Chemistry

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

CO 1	Explain the principles of solution, equilibrium and colloidal chemistry (Understand level)
CO 2	Discuss the degradation chemistry of organic compounds (Understand level)
CO 3	Explain the instrumental methods for determination of chemical and biological characteristics (Understand level)
CO 4	Describe the classification and examination methods of microorganisms (Understand level)
CO 5	Relate the knowledge of microbiology for environmental applications (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	-	-	-	-	-	-	-	-	-	-	2
CO 2	2	-	-	-	-	-	-	-	-	-	-	2
CO 3	3	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	-	-	-	-	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test 1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Physical Chemistry)

Acid Base Equilibria: fundamentals, equilibrium diagrams, buffering.

Concept of Equilibrium chemistry: Factor influencing equilibrium – Activity coefficient, solubility and solubility product.

principle of solvent extraction: Osmosis and reverse osmosis.

Adsorption - Types of adsorption, Isotherms (Langmuir, Freundlich and BET isotherm only), Reaction kinetics (first order, second order and pseudo-first order only), adsorption capacity.

Colloids - properties and stability, Colloidal dispersion - zeta potential.

MODULE II (Organic Chemistry)

Organic contaminants – biodegradable and non-biodegradable, refractory organic pollutants – POPs, PAH, PCAH.

Degradation chemistry of POPs – dyes, pharmaceuticals, dioxins, pesticides, microplastics.

MODULE III (Instrumental methods)

Introduction and basic principle of followings:

Gravimetry, Volumetry, Colorimetry, Fluorimetry, Flame Photometry, Potentiometry, Chromatography – GC, IC, HPLC. Spectro analytical methods - IR, UV and visible, atomic adsorption, atomic emission and mass spectroscopy, XRD, XPS.

Microscopy – SEM, TEM.

MODULE IV (Introduction to microbiology)

Microorganism and their classifications, major group of microorganisms - bacteria, fungi, protozoa, viruses and algae.

Microscopic examination of bacteria: – stains and staining, simple staining and Gram staining, application of simple and compound microscope.

MODULE V (Environmental Microbiology)

Environmental applications of microorganisms – wastewater treatment, solid waste treatment (overview only), Soil microbiology - Microbial flora of soil and interaction among soil microorganisms.

Microbial growth kinetics - Nutritional requirements, Physical conditions for growth, Growth cycle, Monads kinetics.

Overview of Environmental applications of microorganisms: overview of bioremediation using bacteria, fungi, enzymes and microalgae.

Text Books

1. Sawyer and McCarty, Chemistry for Environmental Engineers - Tata McGraw-Hill Education.
2. Pelcazar, Chan and Krieg, Microbiology - McGraw-Hill Education.
3. Benefield, Judkins and Weand, Process Chemistry for Water and Wastewater Treatment, Prentice Hall.

Reference books

1. Maier R. M., Pepper I. L., and Gerba C. P., Environmental Microbiology, Second Edition, Elsevier- AP, 2009.

2. Rittman B, McCarty P L McCarty P, Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
3. Ian L. Pepper, Charles P. Gerba, Terry J. Gentry- Environmental Microbiology, Third Edition, Academic Press 2015.
4. Tortora G. J., Funke B. R., and Case C. L. (2004) Microbiology: An Introduction. Pearson Education (Singapore), Inc.
5. Anil Kumar De, Environmental chemistry, New Age International publishers.
6. "Standard Methods of Testing of Water and Wastewater" Use by APHA, AWWA, AND WPCF (USA) – Latest Edition.
7. Stanley E. Mahajan, "Fundamental of Environmental Chemistry", Lewis Publishers.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hour (48)
MODULE 1 (13 hours)		
1.1	Acid Base Equilibria: fundamentals.	1
1.2	Equilibrium diagrams, buffering.	1
1.3	Concept of Equilibrium chemistry: Factor influencing equilibrium – Activity coefficient.	1
1.4	Solubility and solubility product.	1
1.5	Principle of solvent extraction: Osmosis and reverse osmosis.	1
1.6	Adsorption- Types of adsorption, Adsorbents.	1
1.7	Isotherms: Langmuir, Freundlich.	1
1.8	Isotherms: BET isotherm.	1
1.9	Reaction kinetics: first order, second order.	1
1.10	Pseudo-first order reaction.	1
1.11	Adsorption capacity.	1

1.12	Colloids - properties and stability.	1
1.13	Colloidal dispersion - zeta potential.	1
MODULE II (6 hours)		
2.1	Organic contaminants – biodegradable and non-biodegradable.	1
2.2	Refractory organic pollutants – POPs.	1
2.3	Refractory organic pollutants – PAH, PCAH.	1
2.4	Degradation chemistry of POPs – dyes, pharmaceuticals.	1
2.5	Degradation chemistry of POPs - dioxins, pesticides.	1
2.6	Degradation chemistry of microplastics.	1
MODULE III (10 hours)		
3.1	Gravimetry, Volumetry.	1
3.2	Colorimetry, Potentiometry.	1
3.3	Fluorimetry, Flame Photometry.	1
3.4	Chromatography – GC, IC.	1
3.5	High Performance Liquid Chromatography.	1
3.6	Spectro analytical methods- UV and visible.	1
3.7	Spectro analytical methods- IR.	1
3.8	Atomic adsorption, atomic emission and mass spectroscopy.	1
3.9	Mass spectroscopy - XRD, XPS.	1
3.10	Microscopy – SEM, TEM.	1
MODULE IV (9hours)		
4.1	Microorganism and their classifications.	1

4.2	Major group of microorganisms- bacteria, fungi.	1
4.3	Major group of microorganisms- protozoa, viruses and algae.	1
4.4	Microscopic examination of bacteria: – Types of stains.	1
4.5	Types of staining.	1
4.6	Simple staining.	1
4.7	Gram staining.	1
4.8	Application of simple microscope.	1
4.9	Application of compound microscope.	1
MODULE V (10 hours)		
5.1	Environmental applications of microorganisms – wastewater treatment.	1
5.2	Environmental applications of microorganisms – solid waste treatment.	1
5.3	Soil microbiology - Microbial flora of soil.	1
5.4	Interaction among soil microorganisms.	1
5.5	Microbial growth kinetics.	1
5.6	Nutritional requirements.	1
5.7	Physical conditions for growth, Growth cycle.	1
5.8	Monads kinetics.	1
5.9	Environmental applications of microorganisms.	1
5.10	Bioremediation using bacteria, fungi, enzymes and micro algae.	1

CO Assessment Questions	
CO1	a) Explain the different types of adsorptions b) Define colloids. Brief out the characteristics of colloids and their classification.

CO2	a) Explain the structure and characteristics of any three carcinogenic organic compounds. b) List out some of the pesticides available in the market. Explain their method of degradation.
CO3	a) Describe the working principle of HPLC and ion chromatography. b) Discuss the method of analysis in atomic absorption spectrometer.
CO4	a) Explain the procedure to examine a microorganism using wet mount technique. b) Explain a type of differential stain used to identify microorganisms.
CO5	a) Explain the physical conditions for microbial growth. b) Discuss the application of bioremediation.

Semester 5

B.Tech (Civil Engineering) Curriculum – Semester 5

FIFTH SEMESTER												
Slot	Code	Category	Title	L	T	P	J	S	Hours	Credits	Total Marks	
											CIA	ESE
A	24CET501	PCC	Hydrology and Water Resources Engineering	4	0	0	0	4	4	4	40	60
B	24CEJ502	PBC	Foundation Engineering	2	0	2	2	5	6	5	60	40
C	24CET503	PCC	Environmental Engineering	3	0	0	0	3	3	3	40	60
D	24CEP504	PCC	Design of Structures I	2	1	2	0	4	5	4	60	40
E	24HUT510	HSMC	Management for Engineers	3	0	0	0	3	3	3	40	60
F	24MCT506	MC	Constitution of India	MOOC				3		1*		
G	24CET507	PCC	Artificial Intelligence for Civil Engineers	2	0	0	0	2	2	2	100	
M/H/R	24CEM509 / 24CEH509	MR/HR/RL	MINOR/HONOURS/REMEDIAL	4	0	0	0			4/4/0	40	60
TOTAL								24	23	22		

Honours and Minor Courses

Minor in Civil Engineering

24CEM509	ECOFRIENDLY TRANSPORTATION SYSTEMS

HONOURS					
BASKET 1		BASKET 2		BASKET 3	
STRUCTURAL ENGINEERING AND CONSTRUCTION MANAGEMENT		TRANSPORTATION AND GEOTECHNICAL ENGINEERING		WATER RESOURCES AND ENVIRONMENTAL ENGINEERING	
24CEH519	ADVANCED MECHANICS OF SOLIDS	24CEH529	PAVEMENT CONSTRUCTION AND MANAGEMENT	24CEH539	WATER CONVEYANCE SYSTEMS

24CET501	HYDROLOGY AND WATER RESOURCES ENGINEERING	L	T	P	J	S	C	Year of Introduction
		4	0	0	0	4	4	2024

Preamble: The general objective is to provide a comprehensive understanding of the critical elements in the realm of hydrology and water resources engineering to the students. It aims to impart knowledge about water availability within the hydrosphere, its distribution, quantification, and scientific methods used to compute irrigation water requirements, emphasizing reservoir engineering. As a result of this course, students will have knowledge in fundamental concepts encompassing surface and groundwater aspects of hydrology, alongside the basics of water resources engineering.

Prerequisite: Nil

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

CO1	Explain and estimate the different components of hydrologic cycle by processing hydrometeorological data. (Apply and Analyse Level)
CO2	Calculate the crop water requirements for the design of irrigation canals by recollecting the principles of irrigation engineering. (Apply Level)
CO3	Describe the features of different types of hydraulic structures. (Understand Level)
CO4	Describe and apply the principles of reservoir engineering to estimate the capacity of reservoirs and their useful life. (Apply Level)
CO5	Demonstrate the principles of groundwater engineering and apply them for computing the yield of aquifers and wells. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	3	-	-	1	-	-	-	-	-
CO2	3	3	-	-	-	-	1	-	-	-	-	-
CO3	1	1	-	-	-	-	1	-	-	-	-	-
CO4	3	3	-	-	-	-	1	-	-	-	-	-
CO5	3	3	-	-	-	-	1	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓		✓
Apply	✓	✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Surface Water Hydrology-Rainfall and losses)

Hydrologic cycle – precipitation - mechanism, types, forms and measurement using rain gauges; Optimum number of rain gauges, representation of rainfall data-mass curve and hyetograph, computation of mean precipitation over a catchment, Design rainfall - probable maximum rainfall; IDF curves (concept only). Infiltration - measurement by double ring infiltrometer, Horton's model, infiltration indices. Evaporation – measurement and control.

MODULE II (Surface Water Hydrology-Runoff)

Runoff - components of runoff - Hydrograph analysis - Hydrograph from isolated storm - Base flow separation. Unit hydrograph – uses, assumptions and limitations of unit hydrograph theory.
Computation of storm/flood hydrograph of different duration by method of superposition and by development of S–Hydrograph; Floods - methods of design flood estimation – Empirical methods; SPF and PMF (concept only).

MODULE III (Irrigation Engineering)

Irrigation – Necessity, Benefits and ill-effects. Types: flow and lift irrigation - perennial and inundation irrigation. Soil-water–plant relationships. Irrigation efficiencies, Computation of crop water requirement: depth and frequency of Irrigation. Duty and delta, duty - factors affecting and method of improving duty, Computation of crop water requirement by using the concept of duty and delta; Canal structures - Components of diversion headworks and their functions; Canals - types, Cross section of unlined canals and alignment; design of lined canals; Canal structures - types and functions.

MODULE IV (Reservoir Engineering)

Streamflow measurement - area velocity method of stream gauging, selection of site for stream gauging station, Stage-discharge curve, flow duration curve - uses and characteristics. Reservoirs - types, zones, yield of reservoir; determination of storage capacity and yield by mass curve method; Reservoir sedimentation and control - trap efficiency - computation of life of reservoir. Rule curves and their uses; Dams - types; Gravity dams - components; Instrumentation and grouting.

MODULE V (Groundwater Hydrology)

Vertical distribution of ground water - classification of saturated formation, Aquifer properties, Darcy's law, well hydraulics - Steady radial flow into a fully penetrating well in Confined and Unconfined aquifers; Types of wells, Types of tube wells; well losses; Yield of open wells - pumping test and recuperation test; Groundwater pollution and remediation. (description only)

Text books

- Modi P. N. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors New Delhi 2009.
- Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering, Laxmi Publications (P) Ltd. 2009.

Reference books

1. VenTe Chow. Hand book of Applied Hydrology, Tata McGraw Hill, 1988.
2. Todd D. K. Ground Water Hydrology, Wiley, 2005.
3. Raghunath H. M. Groundwater. New Age International New Delhi 2007.
4. Asawa G. L. Irrigation and Water Resources Engineering New Age International New Delhi 2008.

5. Garg S. K. Hydrology and Water Resources Engineering, Khanna Publishers New Delhi 2005.
6. Garg S. K. Irrigation Engineering and Hydraulic Structures Khanna Publishers New Delhi 2006.
7. Subramanya K. Engineering Hydrology, Tata McGraw Hill, 2013.
8. Raghunath H. M. Hydrology: Principles, Analysis and Design. New Age International New Delhi 2006.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (48)
MODULE 1 (11 hours)		
1.1	Hydrology - Hydrologic cycle.	1
1.2	Precipitation - mechanism, types, forms.	1
1.3	Measurements of rainfall - Use of rain gauges.	1
1.4	Optimum number of rain gauges.	1
1.5	Estimation of missing precipitation by different methods.	1
1.6	Computation of mean precipitation by different methods.	1
1.7	Applications of mean precipitation estimation.	1
1.8	Design rainfall – probable maximum rainfall, return period; IDF curves. (concept only)	1
1.9	Water losses – Infiltration - measurement by double ring infiltrometer, Horton's equation; concept of infiltration indices.	1
1.10	Infiltration indices - Numerical computation.	1
1.11	Evaporation - measurement by IMD land pan, control of evaporation.	1
MODULE II (9 hours)		
2.1	Runoff - Components, factors affecting runoff.	1
2.2	Computation of runoff by different methods.	1

2.3	Hydrograph analysis - Hydrograph from isolated storm - Base flow separation.	1
2.4	Concept of unit hydrograph-assumptions, uses, applications.	1
2.5	Derivation of Unit hydrograph of storm/flood hydrograph.	1
2.6	Derivation of flood hydrograph from UH complex storms.	1
2.7	Computation of storm/flood hydrograph ordinates of different duration – method of superposition.	1
2.8	Computation of storm/flood hydrograph ordinates of different duration – S-Hydrograph.	1
2.9	Floods - methods of design flood estimation – Empirical methods; SPF and PMF.	1
MODULE III (10 hours)		
3.1	Irrigation - Benefits and ill-effects, lift and flow irrigation.	1
3.2	Soil water plant relationships, Irrigation efficiencies.	1
3.3	Computation of crop water requirement: depth and frequency of Irrigation.	1
3.4	Duty and delta - Factors affecting and method of improving duty.	1
3.5	Estimation of crop water requirement by using the concepts of duty and delta - Design discharge for irrigation canals.	1
3.6	Crop water requirement and reservoir volume.	1
3.7	Diversion Headwork - components and functions.	1
3.8	Canals - types and alignment, typical cross sections of unlined canals.	1
3.9	Canal structures - list and functions.	1
3.10	Design of lined canals.	1
MODULE IV (11 hours)		
4.1	Streamflow measurement - measurement of stage and velocity.	1

4.2	Stage-discharge curve - Selection of site for stream gauging station.	1
4.3	Computation of discharge (Area-velocity method) – problem.	1
4.4	Flow duration curves - uses and characteristics.	1
4.5	Reservoirs - types, zones, yield of reservoir.	1
4.6	Storage capacity and yield - by mass curve method.	1
4.7	Reservoir sedimentation - control of sedimentation, trap efficiency.	1
4.8	Useful life of reservoir – computation.	1
4.9	Rule curves and application.	1
4.10	Dams - types; Gravity Dams - Components - Galleries, joints, keys, water stops.	1
4.11	Instrumentation, grouting (brief description only) of gravity dams.	1
MODULE V (7 hours)		
5.1	Vertical distribution of ground water – classification of saturated formation.	1
5.2	Aquifer properties - Darcy's law.	1
5.3	Steady radial flow to a well-unconfined aquifers and unconfined aquifers.	1
5.4	Computation of Steady radial flow to a well.	1
5.5	Steady radial flow to a well – Applications.	1
5.6	Types of wells - open wells and tube well, Types of tube wells - description.	1
5.7	Estimation of yield of an open well - pumping test and recuperation test.	1
5.9	Groundwater pollution and remediation.	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>CO1</td><td>1. Explain different forms of precipitation.
2. Explain the working of a Siphon type raingauge with a neat sketch.
3. A six-hour storm produced rainfall intensities 7, 18, 25, 12, 10 and 3 mm/hr in successive one hour intervals over a basin of 800 km^2. The resulting runoff observed to be 2640 ha.m. Determine the ϕ-index of the storm.</td></tr>
<tr><td>CO2</td><td>1. Explain the limitations of Unit hydrograph theory.
2. Given below are the ordinates of 4 hr UH of a basin. Derive 2 hr UH of the basin using S-curve method.
<table>
<tr><td>Time (hrs)</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td></tr>
<tr><td>UHO (m^3/sec)</td><td>0</td><td>20</td><td>36</td><td>60</td><td>80</td><td>112</td><td>120</td><td>105</td><td>92</td><td>40</td><td>24</td><td>14</td><td>9</td><td>7</td><td>0</td></tr>
</table></td></tr>
<tr><td>CO3</td><td>1. Differentiate duty and delta. Obtain the relation between the two.
2. Draw the typical cross section of unlined canals in cutting and mark the components.
3. The following data pertains to the healthy growth of a crop (i) Field capacity of soil = 29 % (ii) Permanent wilting point = 11 % (iii) Dry density of soil = 1300 kg/m^3 (iv) Effective depth of root zone = 70 cm (v) Daily consumptive use = 12 mm. For healthy growth of crop the moisture content must not fall below 25 % of water holding capacity between Field capacity and Permanent wilting point. How long the crop will survive without irrigation?</td></tr>
<tr><td>CO4</td><td>1. The data pertaining to a stream gauging operation at a gauging station are given below. The rating equation of current meter is $v = 0.51N_s + 0.03$ m/sec where N_s is the number of revolutions per second. Calculate the discharge in the stream.</td></tr>
</table>

	Distance from left water edge (m)	0	1	3	5	7	9	11	12
	Depth (m)	0	1.1	2	2.5	2	1.7	1	0
	Revolutions of current meter kept at 0.6 depth	0	39	58	112	90	45	30	0
	Duration of observation (s)	0	100	100	150	150	100	100	0

2. Explain stage discharge curve and its practical use.
3. Explain the procedure of computing the useful life of a reservoir.

CO5	1. State and Explain Darcy's law and its limitations. 2. Explain (i) storativity (ii) transmissibility (iii) specific yield. 3. A 40 cm diameter well fully penetrates an unconfined aquifer whose bottom is 80 m below the undisturbed groundwater table. When pumped at a steady rate of 1.5 m^3/min, the drawdowns in two observation wells at radial distances of 5 m and 15 m are respectively, 4 m and 2m. Determine the drawdown in the well.

24CEJ502	FOUNDATION ENGINEERING	L	T	P	J	S	C	Year of Introduction
		2	0	2	2	5	5	2024

Preamble: This course is a fundamental exploration of the principles and practices that underpin the construction of stable foundations for various structures. Through this course, student will gain a comprehensive understanding of soil mechanics, geotechnical engineering, and the critical role of foundations in the built environment. After this course, students will be able to recognize practical problems of foundations in real-world situations and respond accordingly.

Prerequisite: 24CET402 Soil Mechanics

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Prepare a bore log and interpret soil profiles based on site investigation data. (Apply Level)
CO2	Develop a soil investigation report & foundation recommendation after analyzing the properties of soil. (Analyse Level)
CO3	Design the shallow foundations. (Analyse Level)
CO4	Determine the possible settlement of foundation after conducting suitable laboratory test. (Apply Level)
CO5	Determine the lateral earth pressure acting on retaining walls. (Analyse Level)
CO6	Explain methods for slope stability analysis. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	-	3	3	3	-	3
CO2	3	3	-	-	3	-	-	3	3	3	-	3
CO3	3	3	-	-	-	-	-	-	2	2	-	-
CO4	3	2	-	-	3	-	-	2	3	3	-	2
CO5	3	3	-	-	-	-	-	-	-	-	-	-
CO6	2	1	-	-	-	-	-	-	-	-	-	-

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	-	✓	✓
Understand	✓	-	✓	✓
Apply	✓	-	✓	✓
Analyse	-	-	✓	-
Evaluate	-	-	✓	-

Create	-	-	✓	-

Assessment Pattern for Lab component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember		
Understand	✓	
Apply	✓	
Analyse	✓	
Evaluate		
Create		

Assessment Pattern for Project component			
Bloom's Category	**Continuous Assessment Tools**		
	Evaluation 1	**Evaluation 2**	**Report**
Remember			
Understand	✓	✓	
Apply	✓	✓	✓
Analyse	✓	✓	✓
Evaluate		✓	✓
Create		✓	✓

Mark Distribution of CIA								
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**		**Practical [P]**	**Project [J]**			**Total Marks**
		Assignment	**Tests**	**Class work**	**Evaluation-1**	**Evalaution-2**	**Report**	
2-0-2-2	5	10	15	10	5	10	5	60

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x 8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5x8 = 40 marks]	

SYLLABUS
Module I (Foundation Type & Site Investigation)
General Considerations: Functions of foundations - definition of shallow and deep foundation - Selection of type of foundation - Different types of shallow foundations - advantages and limitations of various types of shallow foundations. Site investigation and soil exploration: objectives - planning - reconnaissance - Guidelines for choosing spacing and depth of borings. [I.S. guidelines only] Standard Penetration Test – Procedure and correlations - Corrections for SPT value – Numerical Problems - Boring log - Soil profile.
Module II (Bearing capacity of shallow foundations)
Terzaghi's bearing capacity theory for strip footing [no derivation required] – Assumptions - Gross and Net bearing pressure - Ultimate and Safe bearing capacity - Failure mechanism (General, local and punching shear failure) - Allowable soil pressure -– Bearing capacity factors - Numerical problems - Terzaghi's formulae for circular and square footings - Numerical problems - Factors affecting bearing capacity - Effect of water table on bearing capacity - Numerical problems.
Module III (Settlement of Shallow foundation)
Settlement analysis: Introduction - causes of settlement – estimation immediate settlement (I.S. Code) Numerical problems - Field test - Plate load test – Procedure, uses and limitations - Field test - Plate load test – Procedure, uses and limitations. Well foundation: Elements of a well foundation - Tilt & Shift. Combined footings - Rectangular and Trapezoidal combined footings - Numerical problems.

Raft foundations: Types – Principles of design of raft foundation - Bearing capacity equations for raft on sand (Teng's equation based on SPT value) and for raft on clay (Skempton's formula) - Floating foundations.
Module IV (Deep Foundation)
Uses of piles - classification of piles - determination of type and length of piles - Bearing capacity of single pile in clay and sand [I.S. Static formulae] - Numerical problems - Dynamic formulae (Modified Hiley formulae only) – Numerical Problems - I.S. Pile load test [conventional] - Negative skin friction - Group action - Group efficiency - Capacity of Pile groups - Numerical problems.
Module V (Earth Pressure theory & Slope Stability)
Earth pressure - At rest, active and passive earth pressures - Rankine's theory – Earth pressure and point of application for cohesionless and cohesive soils - Influence of surcharge and water table on earth pressure - Numerical problems - Earth pressure with layered backfill - Numerical problems - Coulomb's theory (concept only). Stability of finite slopes - Toe failure, base failure, slip failure - Swedish Circle Method (Procedure only) - Friction circle method (Procedure only) - Taylor's Stability number - Stability charts (Demo only).
Text Books: 1. Ranjan G. and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2002. 2. Arora K. R., Geotechnical Engineering, Standard Publishers, 2006. **Reference Books:** 1. Das B. M., Principles of Geotechnical Engineering, Cengage India Pvt. Ltd., 2010. 2. Venkatramaiah, Geotechnical Engg, Universities Press, 2000. 3. Terzaghi K. and R. B. Peck, Soil Mechanics in Engineering Practice, John Wiley, 1967. 4. Taylor D.W., Fundamentals of Soil Mechanics, Asia Publishing House, 1948.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (24)
Module I (4 hours)		
1.1	General Considerations: Functions of foundations - definition of shallow and deep foundation - Selection of type of foundation - Different types of shallow foundations - advantages and limitations of various types of shallow foundations.	1
1.2	Site investigation and soil exploration: objectives - planning - reconnaissance - Guidelines for choosing spacing and depth of borings (I.S. guidelines only).	1

1.3	Standard Penetration Test – Procedure.	1
1.4	Corrections for SPT value – Numerical Problems.	1
Module II (4 hours)		
2.1	Terzaghi's bearing capacity theory for strip footing [no derivation required] – Assumptions.	1
2.2	Failure mechanism (General, local and punching shear failure) - Gross and Net bearing pressure - Ultimate and Safe bearing capacity - Allowable soil pressure.	1
2.3	Terzaghi's formulae for circular and square footings - Numerical problems.	1
2.4	Factors affecting bearing capacity - Effect of water table on bearing capacity - Numerical problems.	1
Module III (7 hours)		
3.1	Introduction- causes of settlement – estimation immediate settlement (cohesive soil only) – Numerical problems.	1
3.2	Field test - Plate load test – Procedure, uses and limitations.	1
3.3	Well foundation: Elements of a well foundation - Tilt & Shift.	1
3.4	Rectangular combined footings - Numerical problems.	1
3.5	Trapezoidal combined footings - Numerical problems.	1
3.6	Raft foundations: Types – Principles of design of raft foundation.	1
3.7	Bearing capacity equations for raft on sand (Teng's equation based on SPT value) and for raft on clay (Skempton's formula) - Floating foundations.	1
Module IV (4 hours)		
4.1	Uses of piles - classification of piles - Determination of type and length of piles - Bearing capacity of single pile in clay and sand [I.S. Static formulae] - Numerical problems.	1
4.2	Dynamic formulae (Modified Hiley formulae only) – Numerical Problems.	1
4.3	I.S. Pile load test. [conventional]	1
4.4	Negative skin friction - Group action - Group efficiency - Capacity of Pile groups - Numerical problems.	1
Module V (5 hours)		
5.1	Earth pressure - At rest, active and passive earth pressures.	1
5.2	Rankine's theory – Earth pressure and point of application for cohesionless and cohesive soils - Influence of surcharge and water table on earth pressure - Numerical problems.	1

5.3	Earth pressure with layered backfill - Numerical problems - Coulomb's theory. (concept only)	1
5.4	Stability of finite slopes - Toe failure, base failure, slip failure - Taylor's Stability number - Stability charts.	1
5.5	Swedish Circle Method , Friction circle method. (Procedure only)	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours (24)	Experiment
1	Laboratory test for identifying index properties of soil	2	Sieve Analysis
		2	Specific Gravity
		2	Swelling Test & Water Content
		2	Hydrometer analysis
		2	Atterberg Limits
		2	Field Density Test
2	Laboratory test for identifying engineering properties of soil	2	Standard Proctor Compaction Test
		2	Direct Shear Test
		2	Unconfined Compression Test
		2	Consolidation Test
		2	Permeability Test
	Internal Exam	2	Test-1

COURSE PROJECT

Sample project topics for students to work on:

1. Develop a Bore log from a SPT data set.
2. Develop a soil investigation report including the foundation recommendation- Shallow Foundation & Deep Foundation.
3. Audit report on foundation/Earth Retaining structure work - Develop a model of the audited structure using software.

LESSON PLAN FOR PROJECT COMPONENT

No.	Topic	No. of Class Hours [24]
1	Preliminary Design of the Project	4
2	Zeroth presentation (4th week)	2
3	Project work - First Phase	4
4	Interim Presentation (7th and 8th weeks)	4
5	Project work - Final Phase & Report writing (discussions in class during project hours)	6
6	Final Evaluation and Presentation (11th and 12th weeks)	4

CO Assessment Questions	
CO1	1. Determine the minimum number of bore holes needed for a rectangular plot of size (i) 80 m × 100 m and (ii) 300 m × 80 m. 2. Prepare a typical bore log for SPT test.
CO2	A square footing of 2 m × 2 m is provided at a depth of 1 m, in a sandy soil with an angle of internal friction of 30°. Compute the net safe bearing capacity of the soil with a factor of safety of 3, when the water table is at a depth of 0.5 m & 1.5 m below the ground level. Given G = 2.65, e = 0.7, Degree of saturation above water table = 80%, Nc = 95, Nq = 80.4, Nγ = 100.2.
CO3	1. Design a rectangular combined footing for two columns, each of size 250 mm × 250 mm, the magnitude of column loads being 850 kN and 1050 kN. c/c distance between columns is 3.8 m and a clear spacing of 0.125 m only is available beyond the outer face of 850 kN column. Take SBC of subsoil as 202 kPa. 2. A square concrete pile [400 mm × 400 mm] is proposed to be installed in a homogeneous clay stratum [unconfine compression strength = 100 kPa; unit weight of soil = 18 kN/m^3; adhesion factor = 0.4] to carry a safe load of 233 kN, with a factor of safety of 2.5 against shear failure. Design the required length of pile.
CO4	Determine the immediate settlement of a square footing 2 m x 2 m founded on silt at 1.5 m. The footing carries a load of 300 kN. Take Poisson's ratio as 0.3, soil modulus as 10000 kPa and influence factor as 0.8.
CO5	A retaining wall [height = 5m] supports a granular backfill [angle of internal friction = 36^0; unit weight above WT = 16 kN/m^3; unit weight below WT = 19 kN/m^3] WT table is at a depth of 2 m beneath the backfill surface. Determine the total active earth pressure.
CO6	Explain procedure for friction circle method of slope stability analysis.

24CET503	ENVIRONMENTAL ENGINEERING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course intends to impart knowledge on the water requirements, wastewater generation, quality characteristics, and water distribution. The course introduces the various methods of the treatment of water and wastewater. The students will be able to be conversant on the fundamental concepts of public water supply scheme and sewerage systems.

Prerequisite: 24MCT406 Environmental Sciences

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

CO1	Estimate the quantity of water for a locality and to assess the quality characteristics (Apply level)
CO2	Design and develop water treatment systems (Apply level)
CO3	Recommend appropriate water distribution network for a locality and design the network (Apply level)
CO4	Estimate the wastewater quantity generated from a locality and design circular sewers (Apply level)
CO5	Explain wastewater treatment systems and design septic tank (Understand, Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	-	2	-	-	-	-	-	-
CO2	3	2	3	-	-	3	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-	-
CO4	2	3	2	-	-	2	-	-	-	-	-	-
CO5	3	2	3	-	-	3	-	-	-	-	-	-

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test 1	Test-2	
3-0-0-0	5	15	10	10	40

Total Marks distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks) Total Marks: 20	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours Total Marks: [5x8 = 40 marks]	60

SYLLABUS

MODULE I (Quantity and Quality of Water)

Introduction to Environmental Engineering - public water supply scheme: Layout of water supply scheme; per capita demand – influencing factors and variations, water requirements as per IS 1172; design period and its importance; population forecast; intake structures; Water quality characteristics – physical, chemical and bacteriological characteristics, Drinking water standards as per IS 10500.

MODULE II (Water Treatment)

Water Treatment: General Layout of water treatment plant; Types of settling; Stoke's Law for settling velocity of discrete particles, Theory and principle of sedimentation, design of plain sedimentation tank, coagulation – mechanism and common coagulants, design of coagulation, flocculation and sedimentation tanks; mechanism of filtration, slow and

rapid sand filter, design of rapid sand filter, pressure filters; Principle and methods of disinfection, types of chlorination.

MODULE III (Water Distribution)

Water Distribution: Methods of distribution, layout of distribution networks, Pressure requirements, Pipe network analysis - Hardy Cross method and equivalent pipe method; Application of WaterCAD and EPANET for pipe network analysis. (overview only)

MODULE IV (Wastewater Quantity and Sewer Design)

Sewerage systems: Types; Dry and wet weather flow - estimation of wastewater quantity, estimation of storm water flow; sewers – types and hydraulic design of circular sewers for full and partial flow conditions; sewer appurtenances – manholes, catch basin, flushing devices, inverted siphon.

MODULE V (Sewage Treatment)

Sewage Treatment: General layout of sewage treatment plant; Theory of grit chamber, detritus chamber, and equalization tank; sedimentation tanks – primary and secondary; aerobic and anaerobic decomposition; theory and working of activated sludge process and trickling filter, sludge management (basic concepts only); working principle and design of septic tank, plumbing system.

Text Books

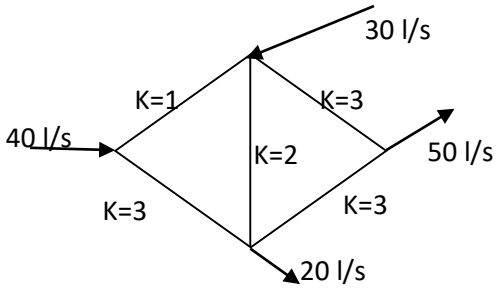
1. Howard S Peavy, Donald R Rowe and George Tchobanoglous, Environmental Engineering, Mc Graw Hill Education, 2013.
2. Mackenzie L Davis, David A Cornwell, Introduction to Environmental Engineering, Mc Graw Hill Education, 2014.
3. S.K.Garg, Water Supply Engineering, Khanna Publishers. 2010.
4. G S Birdie, Water Supply and Engineering, Dhanapat Rai Publishing Co., 2014.
5. J. Arceivala, Shyam R. Asolekar, Wastewater Treatment for Pollution Control and Reuse, McGrawhill Education, 2007.
6. S.K. Garg, Sewage disposal and air pollution engineering, Khanna Publishers. 2008.

Reference books

1. Metcalf and Eddy, Waste Water Engineering, Tata McGraw Hill publishing Co Ltd, 2003.
2. Syed R Qasim, Edward M Motley, Guang Zhu, Water Works Engineering-Planning, Design & Operation, PHI Learning, 2012.
3. Syed R Qasim, Wastewater Treatment Plants-Planning, Design & Operation, CRC Press,1999.
4. Manual on water supply and treatment, Central Public Health and Environmental Engineering Organization, Ministry of Urban Affairs, GoI, 1999.
5. Manual on sewerage and sewage treatment, Central Public Health and Environmental Engineering Organization, Ministry of Urban Affairs, GoI, 2013.
6. IS10500:2012 Drinking Water Specification.
7. IS1172:1993 Code of Basic Requirements for Water Supply, Drainage and

Sanitation.		
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36)
MODULE 1 (7 hours)		
1.1	Introduction to public water supply scheme: Layout of water supply scheme.	1
1.2	Per capita demand – influencing factors and variations, water requirements as per IS 1172, Design period.	1
1.3	Population forecast.	1
1.4	Population forecast.	1
1.5	Intake structures.	1
1.6	Water quality characteristics – physical, chemical.	1
1.7	Water quality characteristics – bacteriological, Drinking water standards as per IS 10500: 2012.	1
MODULE II (9 hours)		
2.1	Water Treatment: General Layout of water treatment plant.	1
2.2	Types of settling; Stoke's Law for settling velocity of discrete particles.	1
2.3	Theory and principle of sedimentation.	1
2.4	Design of plain sedimentation tank.	1
2.5	Coagulation – mechanism and common coagulants, optimum dose of coagulants.	1
2.6	Design of coagulation, flocculation and sedimentation tanks.	1
2.7	Mechanism of filtration, slow and rapid sand filter.	1
2.8	Design of rapid sand filter.	1
2.9	Principle and methods of disinfection, types of chlorination.	1
MODULE III (6 hours)		
3.1	Water Distribution: Methods of distribution.	1

3.2	Layout of distribution networks, Pressure requirements.	1
3.3	Pipe network analysis - Hardy Cross method.	1
3.4	Hardy Cross method.	1
3.5	Equivalent pipe method.	1
3.6	Application of WaterCAD and EPANET for pipe network analysis.	1
MODULE IV (6 hours)		
4.1	Sewerage systems: Types.	1
4.2	Dry and wet weather flow - estimation of wastewater quantity.	1
4.3	Estimation of storm water flow.	1
4.4	Sewers – types.	1
4.5	Hydraulic design of circular sewers for full flow conditions.	1
4.6	Hydraulic design of circular sewers for partial flow conditions.	1
MODULE V (8 hours)		
5.1	Sewage Treatment: General layout of sewage treatment plant.	1
5.2	Theory of grit chamber, detritus chamber.	1
5.3	Equivalization tank; sedimentation tanks – primary and secondary.	1
5.4	Aerobic and anaerobic decomposition.	1
5.5	Theory and working of activated sludge process.	1
5.6	Theory and working of trickling filter.	1
5.7	Working principle and design of septic tank and waste disposal system.	1
5.8	Sludge management, plumbing system.	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>CO1</td><td>1. It is proposed to design a water supply system for a town having an average per capita demand of 150 lpcd. The average design period is 30 years. Compute the capacities to which different components of the supply system may be designed when the population is forecasted using incremental increase method. Also estimate the coincident draft. The data on the population of the town is furnished below:
<table>
<tr><th>Year</th><th>Population</th></tr>
<tr><td>1970</td><td>3,20,000</td></tr>
<tr><td>1980</td><td>4,60,000</td></tr>
<tr><td>1990</td><td>6,90,300</td></tr>
<tr><td>2000</td><td>10,23,600</td></tr>
<tr><td>2010</td><td>12,57,200</td></tr>
</table>
2. Study of existing water supply system of your home town, identify the gaps and recommend modifications</td></tr>
<tr><td>CO2</td><td>1. A city with a population of 75,000 has to be supplied with water from an intake well from a river. The average per capita demand of the city is estimated to be 200 lpcd. It is decided to undergo Type I settling as the primary treatment in the WTP. Design the unit for maximum daily demand.
2. A city with a population of 75,000 has to be supplied with water from an intake well from a river. The average per capita demand of the city is estimated to be 200 lpcd. It is decided to undergo Type I settling as the primary treatment in the WTP. Design the unit for maximum daily demand.
3. A new water treatment plant is being designed for a town of population of 57,000, having an average per capita demand of 130 lpcd. Design an appropriate treatment unit to remove the colloidal solids for maximum daily demand. Prepare neat sketches showing the plan and sectional elevation of the unit.
4. Design a rapid sand filter for a total demand of 6 MLD of water with all its principal components.</td></tr>
<tr><td>CO3</td><td>Analyse the pipe network shown using Hardy Cross method.

</td></tr>
<tr><td>CO4</td><td>1. A town of area 0.25 sqkm has a population of 56,000. 30% of the area consists of roof tops having an impermeability coefficient of 0.95, 25% of the area consists of paved surface of houses having an impermeability</td></tr>
</table>

	coefficient of 0.8, 35% of the area consists of gardens having an impermeability coefficient of 0.5, 10% of the area is unpaved having an impermeability coefficient of 0.2. Compute the discharge of a combined sewerage system if the time of concentration of the rain is 35 min. The per capita demand may be assumed as 135 lpcd. Compute the reduction in the discharge in the sanitary sewer, if the system of sewerage is partially separate. 2. Design a circular sewer to carry a peak sewage discharge of 500 l/s. If the sewer is running 0.6 times full, design the sewer section and the velocity under a slope of 1 in 500. Assume n = 0.012.
CO5	1. Differentiate aerobic and anaerobic decomposition. 2. Illustrate the working of a septic tank and soil dispersion system. 3. Discuss activated sludge process. What are the various process modifications.

24CEP504	DESIGN OF STRUCTURES I	L	T	P	J	S	C	Year of Introduction
		2	1	2	0	4	4	2024

Preamble: The course provides students with a rational basis of the design of reinforced concrete members and structures through the understanding of material and structural behavior. The course covers all the fundamental topics in reinforced concrete design according to the existing codes of practice [IS 456 (2000)]. Through a combination of theoretical concepts and practical laboratory experiments, students will be able to understand the behaviour of concrete and design the various reinforced concrete structural elements.

Prerequisite: 24CEP303 Mechanics of Solids, 24CET401 Structural Analysis

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

CO1	Explain the properties of concrete with respect to strength and workability and the properties of steel used as reinforcement in concrete structures. (Understand Level)
CO2	Explain the fundamental concepts of limit state design and codal provisions for design of concrete members under bending, shear, compression and torsion. (Understand Level)
CO3	Analyse reinforced concrete sections to determine the ultimate capacity in bending, shear and compression. (Apply Level)
CO4	Design and detail beams, slabs, stairs, columns, and footings using IS codes. (Apply Level)
CO5	Evaluate the properties of various concrete-making materials, fresh and hardened concrete by conducting appropriate experiments and prepare a test report. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	1	-	-	-	-	-
CO2	3	-	-	-	-	2	1	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	-	3	-		-	2	-	-
CO5	3	3	2	-	-	-	-	2	3	3	-	1

Assessment Pattern for Theory Component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab Component

Bloom's Category	Continuous Assessment Tools	
	Class work	Test1
Remember	✓	✓
Understand	✓	✓
Apply	✓	✓
Analyse		
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Practical [P]		Total Marks
		Assignment	Test-1	Test-2	Class work	Lab Exam	
2-1-2-0	5	10	12.5	12.5	10	10	**60**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5hrs

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2	Total Marks: 0	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 2.5 hours Total Marks: [5×8 = 40 marks]	40

SYLLABUS

MODULE I (Properties of Concrete and Steel, Design of Singly Reinforced Beams)

Review of Properties of cement and aggregates, Grading Requirements of Aggregate, Water Content and Workability of Concrete, Water-Cement Ratio and Strength, Water for Curing, Admixtures, grade of concrete, characteristic

strength, concrete mix design, behaviour of concrete under uniaxial compression, Stress-Strain Curves, behaviour of concrete under tension, creep of concrete, shrinkage effect in concrete, durability of concrete, Environmental Exposure Conditions and Codal Requirements, the properties of steel used as reinforcement in concrete.

Principles of Limit state method of design, Introduction to BIS code - Types of limit states - characteristic and design values - partial safety factors - types of loads and their factors.

Limit states – Limit state of collapse in flexure – Analysis and design of singly reinforced beams.

MODULE II (Design of Doubly Reinforced Beams, Design for shear, Bond and Torsion)

Analysis & design of doubly reinforced beams. Analysis of T-beams.

Limit state of collapse in shear. Bond and development length. Design for torsion - IS code approach. (procedure only)

MODULE III (Design of Slabs)

Design of slabs – one-way and two-way slabs- Reinforcement detailing.

MODULE IV (Design of Columns)

Limit state of collapse – compression, Design of axially loaded short column, Design of short columns subjected to compression and uniaxial/biaxial bending - design using SP16 charts.

MODULE V (Design of Stairs and Footings)

Staircase, effective span as per IS code provisions, distribution of loading on stairs, Design and detailing of dog-legged stair. tread-riser type stairs (detailing only)

Footings, Design of isolated footings, combined footings (design principles only).

Text books

1. Pillai S.U & Menon D – Reinforced Concrete Design, Tata McGraw Hill Book Co., 2009.
2. Punmia, B. C, Jain A.K and, Jain A. K, R C C Designs, Laxmi Publications Ltd., 10e, 2015.
3. Varghese P.C, Limit State Design of Reinforced Concrete, Prentice Hall of India Pvt Ltd, 2008.

Reference books

1. Indian Standard Plain and Reinforced Concrete – Code of Practice (4th Revision), IS 456: 2000, Bureau of Indian Standards.
2. SP 16 Design Aids for Reinforced Concrete to IS: 456 – 1978, Code of Practice, Bureau of Indian Standards.
3. SP 34 Handbook on concrete reinforcement and detailing, Code of Practice, Bureau of Indian Standards.
4. Ramamrutham S, Design of Reinforced Concrete Structures, Dhanpat Rai Publishers, 2016.
5. Gambhir. M.L. “Design of Reinforced Concrete Structures”, Prentice Hall of India, 2012.
6. Sinha S. N., “Reinforced Concrete Design”, Tata McGraw Hill, 2005.
7. Jain A. K., “Reinforced Concrete – Limit State Design”, Nem Chand & Bros.,

2009.		
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36)
MODULE 1 (8 Hours)		
1.1	Review of Properties of cement and aggregates, Grading Requirements of Aggregate, Water Content and Workability of Concrete.	1
1.2	Water-Cement Ratio and Strength, Water for Curing, Admixtures, grade of concrete, characteristic strength.	1
1.3	Concrete mix design.	1
1.4	Behaviour of concrete under uniaxial compression, Stress-Strain Curves, behaviour of concrete under tension, creep of concrete, shrinkage effect in concrete, durability of concrete, Environmental Exposure Conditions and Codal Requirements, the properties of steel used as reinforcement in concrete.	1
1.5	Principles of Limit state method of design, Introduction to BIS code - Types of limit states - characteristic and design values - partial safety factors - types of loads and their factors, Limit State of Collapse by flexure – assumptions - stress-strain relationship of steel and concrete.	1
1.6	Analysis of singly reinforced rectangular beams – balanced - under reinforced - over reinforced sections - moment of resistance codal provisions.	1
1.7	Design of singly reinforced rectangular beams - basic rules for design.	1
1.8	Tutorial. (Problems on analysis and design of singly reinforced beams)	1
MODULE II (8 Hours)		
2.1	Analysis of doubly reinforced beams.	1
2.2	Design of doubly reinforced beams –detailing.	1
2.3	T-beams – terminology - Formulae for analysis of T beams - examples.	1
2.4	Tutorial. (Problems on analysis and design of doubly reinforced beams)	1
2.5	Limit state of collapse in shear - shear stresses in beams - types of reinforcement - shear strength of RC beam - IS code recommendations for shear design.	1

2.6	Design of shear reinforcement - examples.	1
2.7	Bond and development length - anchorage for reinforcement bars - code recommendations regarding curtailment of reinforcement.	1
2.8	Design for torsion-IS code approach. (procedure only)	1
MODULE III (7 Hours)		
3.1	Design of slabs - introduction - one-way and two-way action of slabs - load distribution in a slab, IS recommendations for design of slabs.	1
3.2	Design of one-way slab - numerical problems – concepts of detailing of continuous slab – code coefficients.	1
3.3	Tutorial. (design of one-way slab)	1
3.4	Two- way slabs - simply supported design using IS Code coefficients -Reinforcement detailing.	1
3.5	Two- way slabs - restrained slabs – design using IS Code Coefficients.	1
3.6	Two- way slabs - restrained slabs – design using IS Code Coefficients- Reinforcement detailing.	1
3.7	Tutorial. (design of two-way slab)	1
MODULE IV (6 Hours)		
4.1	Columns - introduction – classification - effective length - short column - long column – reinforcement - IS specifications regarding columns - limit state of collapse: compression.	1
4.2	Design of axially loaded short columns - design examples with rectangular ties.	1
4.3	Design of axially loaded short columns - design examples with helical reinforcement.	1
4.4	Analysis and design of short columns subjected to compression and uniaxial bending - design using SP16 charts for limit state.	1
4.5	Analysis and design of short columns subjected to combined axial load and biaxial bending moments - code procedure for design - design using SP16 charts for limit state.	1
4.6	Tutorial. (design of columns)	1
MODULE V (7 Hours)		
5.1	Stair cases – Types – proportioning – loads - distribution of loads – codal provisions – Concepts of tread - riser type stairs (detailing only), Design and detailing of dog legged stair.	1

5.2	Tutorial. (design of stairs)	1
5.3	Foundations – classification - IS code provisions for design of isolated footings.	1
5.4	Design of isolated footing.	1
5.5	Design principles of rectangular footings - detailing.	1
5.6	Tutorial. (design of footing)	1
5.7	Combined footings (design principles only) - analysis of combined footings - rectangular and trapezoidal.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours (24)	Experiment
1	TEST ON CEMENT - I	2	a. Fineness b. Specific Gravity c. Soundness (demo)
2	TEST ON CEMENT - II	2	a. Standard Consistency b. Initial & Final Setting Time
3	TEST ON CEMENT - III	2	a. Preparation of Cement mortar cube b. Compressive strength of cement mortar cubes
4	TEST ON AGGREGATES - I	2	a. Particle Size Distribution of Fine & Coarse Aggregates
5	TEST ON AGGREGATES - II	2	a. Specific Gravity & Water Absorption of Coarse Aggregates b. Bulk density, Void ratio & Porosity of Coarse aggregate
6	TEST ON BULKING OF FINE AGGREGATE	2	Bulking of Aggregate
7	TEST ON FRESH CONCRETE	2	a. Workability test i) Slump test, ii) Compacting Factor, b. Preparation of Concrete Cubes, Cylinder and Beams
8	TEST ON HARDENED CONCRETE- I	2	a. Compressive strength of Concrete Cubes b. Modulus of elasticity of

			concrete
9	TEST ON HARDENED CONCRETE- II	2	a. Study on Non-destructive tests on hardened concrete (i) Rebound Hammer (ii) Ultrasonic pulse velocity (iii) Rebar locator
10	TEST ON HARDENED CONCRETE- III	2	a. Flexural Tensile Strength of concrete b. Splitting Tensile Strength
11	TEST ON HARDENED CONCRETE- IV	2	a. Study on (i) concrete core cutter, (ii) crack detection microscope
12	LAB EXAM	2	-

CO Assessment Questions	
1	1. Explain the term workability of concrete, and how is it measured? 2. Explain the term segregation of concrete. Under what circumstances does it take place? 3. Enumerate the steps involved in the Indian Standard method of mix design. 4. Explain the term 'creep of concrete'. Is creep harmful or beneficial?
2	1. Explain the term limit state design. 2. Enumerate the five limit states commonly used in limit state design and state briefly how they are provided for in design. 3. Define the term partial safety factor as used in limit state design. Identify the various factors and state the values recommended in IS 456. 4. Explain the term 'factored load' and 'characteristic loads. Why IS 456 specifies the same partial safety factor for dead and live loads? Is it technically correct? 5. How are the following factors incorporated in design formulae for limit design: (a) partial safety factor for load, (b) partial safety factor for material strength, (c) Difference between cube strength and strength of concrete in structure. 6. Explain the basis for the selection of partial load and safety factors

	by the Code for serviceability limit states. 7. Why is the partial safety factor for concrete greater than that for reinforcing steel in the consideration of ultimate limit states?
3	1. A rectangular beam 250mm wide and effective depth 450 mm has 4 bars of 20mm diameter. Find the moment of resistance of the section if M20 concrete and Fe 415 grade steel are used. As per IS 456:2000 find the limiting moment of resistance also. 2. A rectangular RC beam 230 mm wide and 420 mm effective depth is reinforced with 2-16mm diameter bars at top and 4 – 16 mm bars at bottom. Estimate the ultimate moment carrying capacity of the section assuming M20concrete and Fe415 steel. 3. A square column 300 mm x 300 mm is reinforced with 8 bars of 16 mm diameter. Assuming M25 concrete and Fe415 steel, determine the safe axial load-carrying capacity of the column.
4	1. Design a simply supported beam of span 6m subjected to a live load of 4 kN/m. Use M20 concrete and Fe415 steel. 2. Design a simply supported rectangular beam to carry a superimposed load of 30 kN/m over a span of 5.5 m. Assume support width as 300mm. Maximum overall depth is restricted to 550 mm. Use M20 concrete and Fe 415 grade steel. 3. Design a slab for a room of size 3 m × 5.5 m carrying a live load of 7 kN/m^2. Use M20 concrete and Fe 415 grade steel. Assume that the corners are held down. The slab is having all the four edges discontinuous. 4. Design a square isolated footing for a column of size 400 mm × 400 mm carrying a load of 1500 kN under service conditions. Safe bearing capacity of soil is 200 kN/m^2. Use M20 concrete and Fe 415 grade steel. 5. Design and detail an isolated rectangular footing for a column 400 mm × 600 mm to carry a load of 2000 kN. The SBC of the soil is 180 kN/m^2. Use M20 concrete and Fe 415 grade steel. 6. A dog-legged staircase for a residential flat consists of 18 steps, each of 300 mm tread 180 mm rise, with an intermediate landing 1.2 m in width at the middle. The width of staircase is also 1.2 m. If the flights are of equal number of steps, design the staircase detail the steel. fck = 20 N/mm^2 and fy = 415 N/mm^2. 7. Design a RCC rectangular column to carry an axial load of 1200 kN and a moment of 70 kNm, The length of the column is 3.5 m. The one end is fixed and the other end is hinged. The width of the column is restricted to the wall thickness of 24 cm. 8. Design a reinforced concrete column to carry an axial load of 1600 kN. Use M20 concrete and Fe 415 steel. The column has unsupported length of 3m and is effectively held in position at both the ends, but not restrained against rotation.

5	1. For the given sample of fine aggregate, determine i) moisture content at maximum bulking ii) moisture content at zero bulking iii) percentage of maximum bulking. Assume initial water content as 2 %. 2. a) Determine compressive strength of given cement mortar cube. b) Perform sieve analysis of aggregates which are retained on 4.75 mm sieve size and find out its fineness modulus, effective size, and uniformity coefficient. 3. a) Draw the grading curve and determine the fineness modulus and effective size for the given fine aggregate. b) Determine the fineness of cement. 4. a) Determine compressive strength of given concrete cube. b) Perform sieve analysis of aggregates which passes through 4.75 mm size and find out its fineness modulus, effective size and uniformity coefficient. 5. a)Determine the bulk Density porosity and void ratio of given aggregate. b) Explain the procedure for mix design. 6. a) Determine the standard consistency and fineness of cement. b) Determine the split tensile strength of the concrete specimen by conducting suitable experiment. 7 a) Determine flexure strength of given beam. b) For the given aggregate determine the specific gravity. Assume water absorption as 1 %. 8. Determine the modulus of elasticity of concrete by conducting a test on given concrete cylinders. 9. a) Calculate the volume of concrete required for making a cube, cylinder and beam of standard dimensions. Assume 1:1.4 : 3.1 mix and w/c of 0.47. Take water content as 185 kg per cubic meter of concrete. b) Determine the workability of concrete by conducting slump test. c) Determine the workability of concrete by conducting compacting factor test. 10. a) Calculate the volume of concrete required for making a cube, cylinder and beam of standard dimensions. Assume 1:1.9:3.7 mix and w/c of 0.53. Assume water content as 203 kg per cubic meter of concrete. b) Determine the workability of concrete by conducting compacting factor test. c) Determine the workability of concrete by conducting slump test.

24HUT510	MANAGEMENT FOR ENGINEERS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course intends to introduce the basic concepts and functions of management. An insight into the role of management in the performance of an organization and the various approaches available for managers to achieve excellence is provided in this course. Upon completion of the course, the students will get a clear understanding of the importance of management and its functions in an organization.

Prerequisite: Nil

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

CO1	Describe the characteristics of management in the contemporary context. (Understand level)
CO2	Explain planning and demonstrate ability in the decision-making process. (Understand, Apply level)
CO3	Identify the various types of organizational structures and describe human resources management. (Understand level)
CO4	Explain the importance of leadership and motivation in an organization. (Understand level)
CO5	Discuss the methods and need for control within an organization. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	2	-
CO2	2	-	-	-	-	-	-	-	-	-	3	-
CO3	1	-	-	-	-	-	-	-	-	-	2	-
CO4	1	-	-	-	-	-	-	-	-	-	2	-
CO5	1	-	-	-	-	-	-	-	-	-	2	-

Assessment Pattern for Theory Component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply			✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	**5**	**15**	**10**	**10**	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks) Total Marks: 20	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours Total Marks: [5x8 = 40 marks]	60

SYLLABUS

MODULE I (Introduction to Management Theory)

Introduction to management theory, Management Defined, Characteristics of Management, Management as an art-science-profession, Levels of Manager and Skill required, Task and Responsibilities of a Professional Manager.
Evolution of management – classical, neo-classical, modern approaches to management.

MODULE II (Planning)

Management Process, Planning, Planning types – Vision, Mission, Objectives, Strategy, Policies, Programmes, Procedures, Steps in planning, Management by Objectives.

Decision-making process, Models of decision making, decision making under certainty, risk and uncertainty, Decision trees.

MODULE III (Organizing and Staffing)

Organizing, Principles of Organizing, Organization levels and Span of management, Organization Structures.
Human resource management, HR planning, Recruitment, Selection, Training and Development, Performance Management, Career Planning and Management.

MODULE IV (Leading)

Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

MODULE V (Controlling)

Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.
Benchmarking – importance and limitations of benchmarking.

Text Books

1. Koontz H. and Weihrich H., Essentials of Management: An International Perspective, McGraw-Hill, 11th edition, 2020.
2. Robins S. P. and Coulter M., Management, Prentice Hall India, 11th edition, 2012.
3. Tripathi P. C. and Reddy P. N., Principles of Management, Tata-McGraw Hill, 4th edition, 2008.
4. Stoner J. A. F., Freeman R. E. and Gilbert D. R., Management, Pearson Education, 6th edition (revised), 2018.

Reference books

1. Ashwathappa K., Human Resources and Personnel Management, Tata-McGraw Hill, 4th edition, 2005.
2. Griffin R. W., Management Principles and Applications, 10th Edition, Cengage Learning, 2012.
3. Drucker P. F., The Practice of Management, McGraw Hill, 2006.
4. Daft R. L., New Era of Management, 11th Edition, Cengage Learning, 2016.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (35)
MODULE 1 (7 hours)		
1.1	Introduction to management theory, Definition of Management, Characteristics of Management, Management as an art-science-profession.	1
1.2	Levels of Manager and Skill required.	1
1.3	Task and Responsibilities of a Professional Manager.	1

1.4	Evolution of management – Classical management theories.	1
1.5	Neo-classical management theories.	1
1.6	Modern management theories.	1
1.7	System Approaches to Management.	1
MODULE II (7 hours)		
2.1	Management Process.	1
2.2	Planning, Planning types – Vision, Mission, Objectives, Strategy, Policies, Programmes, Procedures.	1
2.3	Steps in Planning, Management by Objectives.	1
2.4	Decision-making process, Models of decision-making.	1
2.5	Decision-making under certainty and risk.	1
2.6	Decision-making under uncertainty.	1
2.7	Decision trees.	1
MODULE III (7 hours)		
3.1	Organizing, Principles of Organizing.	1
3.2	Organization levels.	1
3.3	Span of management.	1
3.4	Organization Structures.	1
3.5	Human resource management, HR planning.	1
3.6	Recruitment, Selection, Training & Development.	1
3.7	Performance Management, Career Planning and Management.	1
MODULE IV (7 hours)		
4.1	Directing, individual and group behavior.	1
4.2	Motivation, motivation theories – content theories.	1
4.3	Motivation theories – process theories, reinforcement theory.	1
4.4	Motivational techniques, job satisfaction, job enrichment.	1
4.5	Leadership, types.	1
4.6	Leadership theories.	1
4.7	Effective communication.	1
MODULE V (7 hours)		
5.1	Controlling, system and process of controlling.	1
5.2	Budgetary and non-budgetary control techniques.	1
5.3	Use of computers and IT in management control.	1
5.4	Productivity problems and management.	1
5.5	Control and performance.	1

5.6	Direct and preventive control, reporting.	1
5.7	Benchmarking – importance and limitations of benchmarking.	1

CO Assessment Questions	
CO1	1. Discuss the applications of scientific management principles in the modern construction industry. 2. Management is science and art. Justify. 3. Explain the systems approach to management.
CO2	1. Differentiate between objective and strategy with a suitable example. 2. Planning is looking ahead and controlling is looking back. Comment with suitable examples. 3. Mr. Shyam is the author of what promises to be a successful novel. He has the option to either publish the novel himself or through a publisher. The publisher is offering Mr. Shyam Rs. 20,000 for signing the contract. If the novel is successful, it will sell 200,000 copies. Else, it will sell 10,000 copies only. The publisher pays a Re. 1 royalty per copy. A market survey indicates that there is a 70% chance that the novel will be successful. If Mr. Shyam undertakes publishing, he will incur an initial cost of Rs. 90,000 for printing and marketing, but each copy sold will net him Rs. 2. Based on the given information and the decision analysis method, determine whether Mr. Shyam should accept the publisher's offer or publish the novel himself.
CO3	1. Explain the line and staff organizational structure. 2. Distinguish between recruitment and selection.
CO4	1. Summarize the connection between leadership style and situational variables with respect to the LPC Contingency Theory and Situational Leadership Theory. 2. Critically comment on the content theories of motivation.
CO5	1. Differentiate between direct and preventive control. 2. Explain the process of controlling.

24CET507	ARTIFICIAL INTELLIGENCE FOR CIVIL ENGINEERS	L	T	P	J	S	C	Year of Introduction
		2	0	0	0	2	2	2024

Preamble: This course provides an overview of Artificial Intelligence (AI) concepts and their applications in Civil Engineering. This course includes fundamental principles of AI, machine learning and data analysis. It enables the students to explore how AI technologies can be used to address various challenges in Civil Engineering.

Prerequisite: Nil

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

CO1	Describe the concept and applications of AI, ML and DL methods in civil engineering. (Understand Level)
CO2	Describe the principles of supervised learning algorithms. (Understand Level)
CO3	Describe the principles of classification and clustering algorithms. (Understand Level)
CO4	Describe the principles of deep learning algorithms. (Understand Level)
CO5	Demonstrate the applicability of machine learning or deep learning algorithms for classification, clustering and prediction problems in civil engineering through relevant case studies. (Apply Level)
CO6	Demonstrate the applicability of search algorithms for real field optimization problems in civil engineering through relevant case studies. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-	-
CO5	2	-	-	2	-	-	-	-	-	3	-	2
CO6	2	-	-	2	-	-	-	-	-	3	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	
Understand	✓	✓	✓	
Apply			✓	
Analyse				
Evaluate				

Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
2-0-0-0	5	35	30	30	**100**

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	100	0	-

SYLLABUS

MODULE I (Introduction and Background)

Introduction and Types of Machine learning - Supervised, unsupervised and Reinforcement learning, Tasks: regression, classification, clustering.

Types of data, Data preprocessing techniques- Data cleaning, Data Integration, Data Reduction, Data Transformation and Data discretization.

AI in Civil Engineering- Overview:

Application of AI and ML in various fields of Civil Engineering.

MODULE II (Supervised Learning)

Regression- Linear Regression, Multivariate regression; Gaussian Regression, Polynomial Regression, Cost functions – ME, MSE, MAE.

Classification algorithms **–** Logistic regression, K-Nearest Neighbor, Support Vector Machines, Decision Tree - ID3, Naïve Bayes classifier.

Cross validation techniques, Performance Evaluation Measures, Confusion Matrix, ROC curve.

Machine learning applications to prediction/forecasting.

MODULE III (Unsupervised Learning)

Dimensionality Reduction: Principal Component Analysis;

Clustering: Basics & Types of Clustering, similarity / dissimilarity measures, K-means algorithm, Hierarchical clustering, Density based clustering – DBSCAN.

Performance Evaluation Measures – clustering.

Case studies on classification and clustering.

MODULE IV (Introduction to Deep Learning)

Perceptrons, Activation Functions.
Artificial Neural Networks – Forward Propagation, Back propagation;
Convolutional Neural Networks – Convolutional layers, CNN Architecture.
Recurrent Neural Networks- Long-Short Term Memory.
Generative Models - Variational Auto Encoder, Generative Adversarial Networks.
Deep learning applications to prediction, data generation and imputation, fault diagnostics-case studies.

MODULE V (Optimization problem solving)

Use of search algorithms (general philosophy), meta-heuristic optimization methods - genetic algorithms, simulated annealing, swarm intelligence algorithms – ant colony optimization, particle swarm optimization; minimum cost and minimum weight designs, optimal resource allocation.
Applications of recent search algorithms in civil engineering problem solving – case studies.

Text books

1. J. Han, M. Kamber, J. Pei, 'Data Mining- Concepts and Techniques', Third edition, Morgan Kaufmann Publishers, 2012.
2. S.N. Sivanandam, S.N. Deepa, 'Principles of soft computing' Second Edition, Wiley, 2011.
3. E. Alpaydin, 'Introduction to Machine Learning', Third edition, MIT Press.
4. Ian Goodfellow, A. Courville, Y. Bengio, 'Deep Learning', MIT Press, 2017 .(https://www.deeplearningbook.org/).
5. S. Rajasekaran, G.A. Vijayalakshmi Pai, 'Neural Networks, Fuzzy logic, and Genetic Algorithms Synthesis and Applications', PHI Learning Pvt. Ltd, Delhi.
6. Eberhart, Russel C., Shi, Yuhui,Kenney,James, 'Swam Intelligence' The Morgan Kaufmann Series in Evolutionary Computation, 2001.

Reference books

1. Christopher M. Bishop, 'Pattern Recognition and Machine Learning' Springer, 2006.
2. T. Hastie, R. Tibshirani, J Friedman 'The Elements of Statistical Learning: Data Mining, Inference and Prediction', Second Edition, Springer, 2009.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (24)
	MODULE 1 (4 Hours)	
1.1	Introduction and Types of Machine learning - Supervised, unsupervised and Reinforcement learning.	1
1.2	Tasks: regression, classification, clustering.	1
1.3	Types of data, Data preprocessing techniques- Data cleaning, Data Integration, Data Reduction, Data Transformation and Data	1

	discretization.	
1.4	AI in Civil Engineering- Overview: Application of AI and ML in various fields of Civil Engineering.	1
MODULE II (5 Hours)		
2.1	Regression- Linear Regression, Multivariate regression;	1
2.2	Case studies: Gaussian Regression, Polynomial Regression, Cost functions – ME, MSE, MAE.	1
2.3	Classification algorithms – Logistic regression, K-Nearest Neighbor, Support Vector Machines, Decision Tree - ID3, Naïve Bayes classifier.	1
2.4	Cross validation techniques, Performance Evaluation Measures, Confusion Matrix, ROC curve.	1
2.5	Machine learning applications to prediction/forecasting.	1
MODULE III (5 Hours)		
3.1	Dimensionality Reduction: Principal Component Analysis;	1
3.2	Clustering: Basics & Types of Clustering, similarity / dissimilarity measures, K-means algorithm.	1
3.3	Hierarchical clustering, Density based clustering – DBSCAN.	1
3.4	Performance Evaluation Measures – clustering.	1
3.5	Case studies on classification and clustering.	1
MODULE IV (6 Hours)		
4.1	Perceptrons, Activation Functions.	1
4.2	Artificial Neural Networks – Forward Propagation, Back propagation.	1
4.3	Convolutional Neural Networks – Convolutional layers, CNN Architecture.	1
4.4	Recurrent Neural Networks- Long-Short Term Memory.	1
4.5	Generative Models - Variational Auto Encoder, Generative Adversarial Networks.	1
4.6	Deep learning applications to prediction, data generation and imputation, fault diagnostics-case studies.	1
MODULE V (4 Hours)		
5.1	Use of search algorithms (general philosophy), meta-heuristic optimization methods.	1

5.2	genetic algorithms, simulated annealing, swarm intelligence algorithms – ant colony optimization.	1
5.3	Particle swarm optimization; minimum cost and minimum weight designs, optimal resource allocation.	1
5.4	Applications of recent search algorithms in civil engineering problem solving – case studies.	1

CO Assessment Questions	
CO1	1. Describe briefly the Data preprocessing techniques. 2. Differentiate between Supervised, Unsupervised and Reinforcement Learning. 3. Differentiate between Training data and Testing Data.
CO2	1. Describe various classification algorithms. 2. Explain the principles of Support Vector Machine algorithm. 3. Explain Naive Bayes Classifier with an Example.
CO3	1. Discuss the types of Clustering. 2. Write notes on similarity / dissimilarity measures. 3. Explain the k-Means Algorithm with an example.
CO4	1. Write notes on i) Perceptron ii) Activation Functions. 2. Explain in detail about the components of CNN model. 3. How does RNN process data sequences?
CO5	Perform a term paper presentation based on two case studies on machine learning application for predictive modeling in civil engineering.
CO6	Perform a term paper presentation based on application of particle swam optimization in civil engineering.

MINOR & HONOURS COURSES

24CEM509	ECO-FRIENDLY TRANSPORTATION SYSTEMS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: This course aims to provide a comprehensive understanding of eco-friendly transportation systems and their environmental and social impacts. It explores a wide range of eco-friendly transportation options, from public transit to sustainable fuel choices and technological innovations, while emphasizing their benefits and addressing the challenges associated with adoption. At the end of the course, students will be able to grasp sustainable transportation's significance, conventional transport impacts, eco-friendly options, technological progress, benefits and challenges, and the ability to identify local requirements and adopt incentive-driven solutions.

Prerequisite: Nil

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Discuss the importance of sustainable transportation and the environmental and social impacts of conventional transport systems. (Understand Level)
CO2	Recognize and assess various eco-friendly transportation choices, such as public transit, cycling, electric/hybrid vehicles, and pedestrian-friendly infrastructure. (Remember Level)
CO3	Summarize the knowledge of technological advancements and innovations in transportation systems. (Understand Level)
CO4	Interpret the benefits and challenges of eco-friendly transportation. (Understand Level)
CO5	Identify eco-friendly transportation approaches tailored to local requirements, adhering to regulations. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	2	-	-	-	-	-
CO2	1	-	-	-	-	-	2	-	-	-	-	-
CO3	2	1	-	-	-	-	3	-	-	-	-	-
CO4	1	-	-	-	-	-	2	-	-	-	-	-
CO5	2	1	-	-	-	-	3	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				

Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS
Module I (Introduction to Eco-Friendly Transportation Systems)
Definition of eco-friendly transportation - Importance of eco-friendly transportation in the modern world - Environmental and social impacts of conventional transportation systems - The need for sustainable alternatives.
Module II (Types of Eco-Friendly Transportation)

Overview of various eco-friendly transportation options - Public transportation: buses, trams, subways, and light rail - Cycling as a mode of eco-friendly transport - Electric and hybrid vehicles - Walking and pedestrian-friendly infrastructure.
Module III (Technology and Innovations)
Sustainable fuel options, including electric, hydrogen, and biofuels - Energy-efficient vehicle designs - Smart transportation systems and traffic management - Advancements in battery technology - Integrating renewable energy sources into transportation.
Module IV (Benefits and Challenges)
Environmental benefits of eco-friendly transportation - Reduced greenhouse gas emissions - Health and social benefits - Economic considerations - Challenges and barriers to adoption, including infrastructure and cost.
Module V (Implementation and Policy)
Government policies and regulations promoting eco-friendly transportation - Incentives for individuals and organizations to adopt eco-friendly transportation - Case studies of cities successfully implementing eco-friendly transportation systems - Future prospects and trends in eco-friendly transportation - The role of communities and individuals in promoting sustainable transport.
Text Books: 1. Eftestøl-Wilhelmsson, E., Sankari, S., & Bask, A. (Eds.). (2019). Sustainable and Efficient Transport: Incentives for Promoting a Green Transport Market. Edward Elgar Publishing. 2. Abdallah, T. (2023). Sustainable mass transit: Challenges and opportunities in urban public transportation. Elsvier 3. Papacostas, C. S., & Prevedouros, P. D. (1993). Transportation engineering and planning. Pearson **Reference Books:** 1. McClintock, H. (Ed.). (2002). Planning for cycling: principles, practice and solutions for urban planners. Elsevier. 2. Faulin, J., & Serrano-Hernandez, A. (2018). Green Transportation Logistics: The Quest for Win-Win Solutions. Springer 3. Kadiyali, L. R. (2013). Traffic engineering and transport planning. Khanna publishers.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (48)
Module 1 (8 Hours)		
1.1	Definition of eco-friendly transportation.	1
1.2	Importance of eco-friendly transportation in the modern world.	1
1.3	Importance of eco-friendly transportation in the modern world.	1

1.4	Environmental and social impacts of conventional transportation systems.	1
1.5	Environmental and social impacts of conventional transportation systems.	1
1.6	Environmental and social impacts of conventional transportation systems.	1
1.7	The need for sustainable alternatives.	1
1.8	The need for sustainable alternatives.	1
Module II (10 Hours)		
2.1	Overview of various eco-friendly transportation options.	1
2.2	Public transportation: buses, trams, subways, and light rail.	1
2.3	Public transportation: buses, trams, subways, and light rail.	1
2.4	Public transportation: buses, trams, subways, and light rail.	1
2.5	Cycling as a mode of eco-friendly transport.	1
2.6	Cycling as a mode of eco-friendly transport.	1
2.7	Electric and hybrid vehicles.	1
2.8	Electric and hybrid vehicles.	1
2.9	Walking and pedestrian-friendly infrastructure.	1
2.10	Walking and pedestrian-friendly infrastructure.	1
Module III (10 Hours)		
3.1	Sustainable fuel options, including electric, hydrogen, and biofuels.	1
3.2	Sustainable fuel options, including electric, hydrogen, and biofuels.	1
3.3	Energy-efficient vehicle designs.	1
3.4	Energy-efficient vehicle designs.	1
3.5	Smart transportation systems and traffic management.	1
3.6	Smart transportation systems and traffic management.	1
3.7	Advancements in battery technology.	1
3.8	Advancements in battery technology.	1
3.9	Integrating renewable energy sources into transportation.	1
3.10	Integrating renewable energy sources into transportation.	1

Module IV (9 Hours)		
4.1	Environmental benefits of eco-friendly transportation.	1
4.2	Environmental benefits of eco-friendly transportation.	1
4.3	Reduced greenhouse gas emissions.	1
4.4	Health and social benefits.	1
4.5	Health and social benefits.	1
4.6	Economic considerations.	1
4.7	Economic considerations.	1
4.8	Challenges and barriers to adoption, including infrastructure and cost.	1
4.9	Challenges and barriers to adoption, including infrastructure and cost.	1
Module V (11 Hours)		
5.1	Government policies and regulations promoting eco-friendly transportation.	1
5.2	Government policies and regulations promoting eco-friendly transportation.	1
5.3	Incentives for individuals and organizations to adopt eco-friendly transportation.	1
5.4	Case studies of cities successfully implementing eco-friendly transportation systems.	1
5.5	Case studies of cities successfully implementing eco-friendly transportation systems.	1
5.6	Case studies of cities successfully implementing eco-friendly transportation systems.	1
5.7	Future prospects and trends in eco-friendly transportation.	1
5.8	Future prospects and trends in eco-friendly transportation.	1
5.9	Future prospects and trends in eco-friendly transportation.	1
5.10	The role of communities and individuals in promoting sustainable transport.	1
5.11	The role of communities and individuals in promoting sustainable transport.	1

CO Assessment Questions	
CO1	Discuss the significance of the environmental and social impacts of traditional transportation systems in emphasizing the need for sustainable alternatives in the contemporary world.

CO2	List out some examples of public transportation modes that fall under eco-friendly transportation options.
CO3	Explain how advancements in battery technology contribute to the sustainability of transportation systems.
CO4	Discuss how do economic considerations, such as the potential cost savings, align with the environmental benefits of eco-friendly transportation.
CO5	Explain the ways in which communities and individuals actively participate in promoting sustainable transport and supporting the goals of eco-friendly transportation systems.

24CEH519	ADVANCED MECHANICS OF SOLIDS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble:

The primary goal of the course is to deepen the understanding of students on how solid materials behave under different loads and also improve their problem-solving skills in this domain. It covers topics such as stress and strain analysis, elasticity theories, and failure criteria. After this course, students will be equipped with the knowledge and skills needed to analyse elastic materials under load and prepare them for further studies in the field of mechanics of solids.

Prerequisite: 24CEP303 Mechanics of Solids

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

CO1	Identify the advanced mathematical concepts and tools required to analyse elastic materials. (Understand Level)
CO2	Explain the state of stress developed in solids. (Understand Level)
CO3	Explain the state of strain developed in solids. (Understand Level)
CO4	Illustrate the constitutive relation, apply and analyse problems in mechanics. (Apply Level)
CO5	Explain different failure theories and apply failure criteria. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply		✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
[4-0-0-0]	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks) Total Marks: 20	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours Total Marks: [5x8 = 40 marks]	60

SYLLABUS
MODULE I (Mathematical Requisite)
Tensor Notations, Einstein's Summation Convention, Scalar Product, Cross Product, Mixed Triple Product, Kronecker delta, Levi-Civita Symbol, Decomposition of Tensors, Tensor Invariants, Scalar Field and Gradient, Vector Field and Gradient, Curl and Divergence of a Vector Field, Chain Rule of Differentiation.
MODULE II (Stress in 3D)
Definition of stress at a point, Stress Notation, Stress Tensor, Normal stress and Shearing Stress on an oblique plane, Transformation of stress, Principal Stress, Stress Invariants, Octahedral Planes & Octahedral Stress, Mean and Deviator Stress, Plane

stress, Mohr's Circle in Three Dimensions, Planar Stress Condition, Differential Equations of motion of a deformable body.

MODULE III (Strain in 3D)

Types of Strain, Deformation of a deformable body, Strain-Displacement Models, Legrangian & Eulerian Description for displacement, Green's Strain Tensor, Legrangian Finite Strain Tensor, Cauchy's Strain tensor, Eulerian Finite Strain Tensor, Strain Transformation, Spherical and Deviatorial Strain Tensor, Principal Strains, Strain Invariants, Octahedral Strains, Mohr Circle for strain, Cubical Dilatation, Equations of Compatibility for Strain, Strain Rosettes, Constitutive Law.

MODULE IV (Elements of Theory of Elasticity)

Generalized Hooke's Law, Anisotropic Elasticity, Monoclinic Elasticity, Orthotropic Elasticity, Transversely Isotropic Elasticity, Isotropic Elasticity, Lame's Constant, Elasticity Matrix, Compliance Matrix, Displacement based formulations, Stress based Formulations, State of plane stress and plane strain, St Venant's Principle.

MODULE V (Failure and Failure criteria)

Modes of failure, yield failure criteria, Maximum Principal Stress Criteria, Maximum Shear stress criteria, Maximum Strain Criteria, Maximum Strain Energy Density Criteria, Von Mises Criteria, fatigue, Stress Concentration Factor, Palm Miner Rule, SN Curve.

Text books

1. A.P. Boresi and O.M. Sidebottom, Advanced Mechanics of Materials, 4th edition, John Wiley & Sons,1985.
2. R.D. Cook and W.C. Young, Advanced Mechanics of Materials, 2nd edition, Prentice Hall Intl. Inc.1999.
3. L.S. Srinath, Advanced Mechanics of Solids, Tata McGraw Hill, 3e, 2009.

Reference books

1. Edward Tsudik, Analysis of structures on Elastic Foundations, Cengage Learning , J.Ross Publishing, 2012.
2. S.P. Timoschenko, Strength of Materials Vol II ,CBS Publishers, 2002.
3. E.H. Shames, Mechanics of Deformable solids, Prentice Hall Inc., 1964.
4. S.P. Timoshenko and J.N. Goodier, Theory of elasticity, McGraw Hill, 3e, 1970.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (48)
	MODULE 1 (6 hours)	
1.1	Tensor Notations, Einstein's Summation Convention.	1
1.2	Scalar Product, Cross Product, Mixed Triple Product.	1
1.3	Kronecker delta, Levi-Civita Symbol, Decomposition of Tensors.	1

1.4	Tensor Invariants, Scalar Field, and Gradient.	1
1.5	Vector Field and Gradient, Curl, and Divergence of a Vector Field.	1
1.6	Chain Rule of Differentiation.	1
MODULE II (10 hours)		
2.1	Definition of stress at a point, Stress Notation.	1
2.2	Stress Tensor.	1
2.3	Normal stress and Shearing Stress on an oblique plane.	1
2.4	Transformation of stress.	1
2.5	Principal Stress.	1
2.6	Stress Invariants.	1
2.7	Octahedral Planes & Octahedral Stress.	1
2.8	Mean and Deviator Stress, Plane stress.	1
2.9	Mohr's Circle in Three Dimensions, Planar Stress Condition.	1
2.10	Differential Equations of motion of a deformable body.	1
MODULE III (10 hours)		
3.1	Types of Strain, Deformation of a deformable body.	1
3.2	Strain- Displacement Models.	1
3.3	Legrangian and Eulerian Description for displacement.	1
3.4	Green's Strain Tensor and Legrangian Finite Strain Tensor.	1
3.5	Cauchy's Strain tensor and Eulerian Finite Strain Tensor.	1
3.6	Strain Transformation, Spherical and Deviatorial Strain Tensor.	1
3.7	Principal Strains.	1
3.8	Strain Invariants and Octahedral Strains.	1
3.9	Mohr Circle for strain, Cubical Dilatation.	1
3.10	Equations of Compatibility for Strain, Strain Rosettes, Constitutive Law.	1
MODULE IV (12 hours)		
4.1	Generalized Hooke's Law.	1
4.2	Anisotropic Elasticity.	1
4.3	Monoclinic Elasticity.	1
4.4	Orthotropic Elasticity.	1
4.5	Transversely Isotropic Elasticity.	1
4.6	Isotropic Elasticity.	1
4.7	Lame's Constant and Elasticity Matrix.	1
4.8	Compliance Matrix.	1
4.9	Displacement based formulations.	1
4.10	Stress based Formulations.	1
4.11	State of plane stress and plane strain.	1
4.12	St Venant's Principle.	1
MODULE V (10 hours)		
5.1	Modes of failure.	1

5.2	Yield failure criteria.	1
5.3	Maximum Principal Stress Criteria.	1
5.4	Maximum Shear stress criteria.	1
5.5	Maximum Strain Criteria.	1
5.6	Maximum Strain Energy Density Criteria.	1
5.7	Von Mises Criteria.	1
5.8	Fatigue.	1
5.9	Stress Concentration Factor.	1
5.10	Palm Miner Rule and SN Curve.	1

CO Assessment Questions	
CO1	1. Explain Einstein's Summation Convention. 2. Explain Levi-Civita Symbol.
CO2	1. Explain stress invariants. 2. Explain Stress space and transformation of stress. 3. List the differential equations of equilibrium for three-dimensional stress state. 4. Explain stress tensor, Principal stress and octahedral stresses. 5. A square shaft has 42.0 mm sides and has the same cross sectional area as shafts having circular and equilateral triangular cross sections. If each shaft is subjected to a torque of 1kNm, Determine the maximum shearing stress for each of the three shafts. 6. Derive the expression for the stress on arbitrarily plane whose unit normal vector is defined by li+mj+nk for a rectangular coordinate system with x,y and z as reference axes. 7. Find the expression for the Normal stress and Shearing stress on a new coordinate system with X,Y and Z as the reference axes. X axis is defined by l1i +m1j+n1k , Y axis is defined by l2i+m2j+n2k and Z axis is defined by l3i +m3j+n3k 8. A rectangular bar of metal of cross section 20 mm x 35 mm is subjected to an axial tensile force of 180 kN. Calculate the normal, shear and resultant stresses on a plane whose normal has the following direction cosines $l=m=n=1/\sqrt{3}$ 9. The state of stress at a point is given by the following array of terms 3 6 3 [6 6 2] 3 2 9 MPa. Determine the principal stresses and the principal directions. Find out the stress invariants in principal plane and show that it remains unchanged.
CO3	1. Explain the transformation of strain. 2. Explain Principal strain. 3. Distinguish between rectangular strain rosette and equiangular strain rosette.

	4. Explain strain tensor. 5. Explain octahedral strain. 6. By means of strain rosette, the following strains were recorded during the test on a structural member. ε_0 = 950 micrometres/m, ε_{45} = -110 micrometres/m, ε_{90} = 110 micrometres/m. Determine the magnitude and directions of principal strains. 7. Under what conditions are the following expressions for the components of strain at a point compatible? $\varepsilon_x = 2axy^2 + by^2 + 2cxy$, $\varepsilon_y = ax^2 + bx$, $\gamma_{xy} = \alpha x^2 + \beta xy + ax^2 + \eta y$
CO4	1. State the assumptions in classical linear elasticity. 2. List the six compatibility equations for a three-dimensional system. 3. If the displacement field in a body is specified as $u = (x^2+4)\ 10^{-3}$, $v = 5y^2z * 10^{-3}$ and $w = (x + 2z)\ 10^{-3}$. Determine the strain tensor at a point whose coordinates are (3,2,3) 4. The state of strain at a point is given by strain tensor. $\begin{bmatrix} 0.002 & 0 & -0.002 \\ 0 & -0.004 & 0.0006 \\ -0.002 & 0.0006 & 0 \end{bmatrix}$ Determine stress tensor at this point. Take E = 200 GPa. Poisson's ratio = 0.3. 5. The stress components at a point in a body are given by $\sigma_x = 5xy^2z + 2x$, $\sigma_y = 3xyz + 3y$, $\sigma_z = x^2y + y^2z$, $\tau_{xy} = 0$, $\tau_{yz} = \tau_{xz} = 2xy^2z + 2xy$. Determine whether these components of stress satisfy the equilibrium equations or not at the point (1,-1,2). If not then determine the suitable body force required at this point so that these stress components are under equilibrium.
CO5	1. Discuss the failure criteria for ductile materials. 2. Discuss the failure criteria for brittle materials. 3. Explain Palm miner rule. 4. Discuss the failure due to stress reversal. 5. Explain SN Curve. 6. Explain stress concentration factor. 7. A low carbon steel shaft is designed to have a diameter of 25 mm. It is to be subjected to an axial load P= 20 kN , a moment M = 130 Nm, and a torque T = 220 Nm. If the yield point for the steel is 260 MPa, determine the factor of safety used in the design of the shaft based on the a) Tresca criterion of failure b)Von mises criterion of failure assuming that failure occurs at initiation of yielding. 8. Represent all the yield criteria for failure graphically in the 2D stress

		space with rectangular axes σ_1 and σ_2 for the material steel. Assume the yield point of steel as 350 MPa and Poisson ratio as 0.25. Mention the equation also in the graph.
	9.	A closed end thin-walled cylindrical of a metal with yield point = 700 MPa has an inside diameter of 20mm. The cylinder is subjected to an internal pressure of 22 MPa and an axial load of 50 kN. Determine the torque that can be applied to the cylinder if the factor of safety for design is 1.80. Check whether the material is safe under Von mises criteria.

24CEH529	PAVEMENT CONSTRUCTION AND MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: The objective of this course is to enhance the knowledge and understanding of students regarding the various pavement systems and their evaluation. This covers the various pavement types, design of pavement mix, construction practices, different equipment for pavement construction, and evaluation methods. This course enables the students to design and analyze various pavement types.

Prerequisite: NIL

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

CO1	Identify the characteristics of materials used for pavement construction. (Remember Level)
CO2	Interpret mix design of various bituminous mixes. (Understand Level)
CO3	Describe construction practices of flexible pavement and equipment used. (Remember Level)
CO4	Describe the construction practices and reinforcement design of rigid pavement. (Remember and Understand Level)
CO5	Examine the fundamentals of pavement evaluation and pavement management system. (Remember and Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-	-
CO4	-	2	-	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks) Total Marks: 20	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours Total Marks: [5x8 = 40 marks]	60

SYLLABUS

MODULE I (Introduction to Pavement)

Pavement: functions and characteristics- Types of pavement: flexible pavement, rigid pavement, comparison- Different layers of flexible and rigid pavement. Pavement materials: characterization of sub grade soil, soil classification system, properties of road aggregate, principles and methods of gradation of soil aggregate mixes, characteristics and uses of bitumen, emulsion cutback and modified bitumen.

MODULE II (Design of Flexible Pavements)

Bituminous pavement types: penetration layer system and premixed aggregate - specification of materials, Mix design: physical and volumetric properties of bituminous mix, Marshall method of mix design, Super pave mix design.

MODULE III (Construction of Flexible Pavements)

Construction of flexible pavement: functions of various layers, preparation and construction of subgrade, Granular Sub Base (GSB), Water Bound Macadam (WBM),

Wet Mix Macadam (WMM), Bituminous macadam, Different types of wearing courses. Specifications/ guidelines, equipment used for the construction of different layers in flexible pavement, quality control for flexible pavement construction.

MODULE IV (Rigid Pavements)

Construction of cement concrete pavement: material characterization, preparation of subgrade and base, Types of joints in Rigid pavements its functions and design, presetting reinforcement in joints and Plain Cement Concrete (PCC) slab construction.

MODULE V (Pavement Management System)

Introduction to pavement management system (PMS): concept, definition, objectives, components, general structure - data collection pavement evaluation, functional and structural evaluation, pavement deterioration models, pavement management levels: network, programme and project level - types of pavement management system, Types of Maintenance and rehabilitation activities, life cycle cost analysis of strategies, popular software.

Text books

1. Khanna, S.K, Justo E.G, A Veeraragavan, Highway Engineering 10th edition, Khanna Publishers, 2018.
2. Kadiyali, L. R., Principles of Highway Engineering, Khanna Publishers, 2001.
3. Yang, H, Huang, Pavement Analysis and Design Second Edition, 2004.

Reference books

1. Rajib B. Mallick and TaharEl-Korchi, Pavement Engineering CRC press, 2009.
2. Rao G. V, Principles of Transportation and Highway Engineering, Tata McGraw Hill, 1996.
3. Prithvi Singh Khandhal, Bituminous Road Construction in India, PHI Learning, 2019.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (45)
	MODULE 1 (9 hours)	
1.1	Pavement: functions and characteristics.	1
1.2	Types of pavement: flexible pavement, rigid pavement, comparison.	1
1.3	Different layers of flexible and rigid pavement.	1
1.4	Pavement materials: characterization of sub grade soil.	1
1.5	Soil classification system, properties of road aggregate.	1
1.6	Principles and methods of gradation of soil aggregate mixes.	1
1.7	Characteristics and uses of virgin bitumen, emulsion cutback and modified bitumen.	1
1.8	Characteristics and uses of emulsion cutback.	1
1.9	Characteristics and uses modified bitumen.	1

MODULE II (9 hours)		
2.1	Bituminous pavement types: penetration layer system aggregate - specification of materials.	1
2.2	Bituminous pavement types: premixed layer aggregate - specification of materials.	1
2.3	Gradation of aggregate mixes - Mechanical stabilization.	1
2.4	Methods of aggregate gradation.	1
2.5	Mix design: Physical properties of bituminous mix.	1
2.6	Mix design: Volumetric properties of bituminous mix.	1
2.7	Basic requirements of various pavement layers.	1
2.8	Marshall method of mix design.	1
2.9	Super pave mix design.	1
MODULE III (9 hours)		
3.1	Construction of flexible pavement: functions of various layers, preparation.	1
3.2	Construction of subgrade, granular sub base. (GSB)	1
3.3	WBM, WMM properties and specifications.	1
3.4	Bituminous macadam properties and specifications.	1
3.5	Different types of wearing courses.	1
3.6	Specifications/ guidelines for the construction of different layers in unbound flexible pavement layers.	1
3.7	Specifications/ guidelines for the construction of different layers in bound flexible pavement layers.	1
3.8	Equipment used for the construction of different layers in flexible pavement.	1
3.9	Quality control for flexible pavement construction.	1
MODULE IV (9 hours)		
4.1	Construction of cement concrete pavement: material characterization.	1
4.2	Desirable properties of Hardened concrete.	1
4.3	Mix design of Pavement Quality Concrete (PQC).	1
4.4	Preparation of subgrade and base.	1
4.5	Factors affecting design of Rigid pavement.	1
4.6	Various stresses on Rigid pavement.	1
4.7	Types of joints in Rigid pavements and its functions.	1
4.8	Design of Rigid pavements.	1
4.9	Presetting reinforcement in joints and PCC slab construction.	1
MODULE V (9 hours)		
5.1	Introduction to pavement management system (PMS): concept, definition, objectives.	1
5.2	Pavement Management System - Objectives.	1

5.3	Components, general structure of PMS and data collection.	1
5.4	Pavement evaluation- Functional.	1
5.5	Structural Evaluation of pavement.	1
5.6	Pavement deterioration models, pavement management levels: network, program and project level.	1
5.7	Types of pavement management system.	1
5.8	Types of Pavement maintenance and rehabilitation activities.	1
5.9	Life cycle cost analysis of strategies, popular software.	1

CO Assessment Questions	
CO1	Explain the properties of bitumen favorable for road construction.
CO2	Elaborate the mix design procedure to find optimum bitumen content.
CO3	Explain the steps in construction of flexible pavement.
CO4	Describe the construction practices employed in rigid pavement.
CO5	Examine the fundamentals of pavement evaluation and pavement management system.

24CEH539	WATER CONVEYANCE SYSTEMS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: The goal of this course is to provide students with an understanding of the principles, design, and operation of water transportation infrastructure. The primary objective is to equip them with the expertise needed to assess, plan, and manage efficient conveyance systems that ensure the reliable distribution of water resources. As a result of this course, students will emerge with the ability to contribute to the sustainable and effective management of water conveyance systems.

Prerequisite: Nil

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Explain the concepts of water quantity management. (Understand Level)
CO2	Describe the various water collection and distribution system. (Understand Level)
CO3	Identify the components of the water conveyance system. (Understand Level)
CO4	Discuss the fundamentals of the urban drainage system. (Understand Level)
CO5	Choose the suitable urban drainage management system and storm water management system. (Understand and Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply			✓	
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS
Module I (Water Quantity Management)
Water Quantity Management: Surface Water Storage Requirements, Storage Capacity and Yield, Reservoir Design, Water Allocations for Water Supply, Irrigation, Hydropower and Flood Control, Reservoir Operations, Planning of an Irrigation System, Irrigation Scheduling, Groundwater management, Conjunctive Use of Surface and Subsurface Water Resources.
Module II (Collection & Distribution of water)
Collection and Distribution of Water: intakes, methods of distribution, storage, flow estimation, pressures, design of networks, system maintenance, and protection of water quality in systems.

Pumps and pumping Stations: types, characteristic curves, system curves, and optimal operation.

Module III (Conveyance of Water)

Aqueducts and Pipes: conveyance and distribution, stresses in pipes, pipe material, valves, corrosion, effect on water quality, and other appurtenances.

Types of pipes used for conveyance, Pipe joints, Laying of Pipes, Distribution system, Types of valves and Meters, Pipe fittings and fixtures, Necessity, Methods to prevent leaks, Measures for conservation of water.

Module IV (Urban Drainage)

Approaches to Urban Drainage, Urban Wastes and Urban Runoff Options for Waste Disposal, Separate and Combined Systems open Channels and closed Conduits, Wastewater and Stormwater Reuse.

Elements of Drainage System Conveyance Elements, Appurtenances, Overflow Structures, Runoff Control, Pumping Stations. Design Parameters, Design Period, Catchment, Physical Parameters, Process Parameters Rainfall, Water quality Parameters, Instrumentation for Data Collection.

Module V (Stormwater Management)

Quantity of Stormwater, Stormwater Analysis, Rainfall Excess and Abstractions, Calculation of Runoff Volume and Peak Flow Hydrologic and Hydrodynamic methods. Hydraulic Design of Conveyance Elements, Sizing of sewers and drainage Channels, Design of Appurtenances, Layout of Road Drainage, Layout of Pumping Stations. (illustration only)

Control Runoff and Pollution, On-site Storage and Use of Stormwater, infiltration, Detention and Retention Facilities for Stormwater Treatment, Erosion Control Measures. Stormwater management models.

Text Books:

1. Chaturvedi, M.C. (1987), “Water Resources Systems Planning and Management”, Tata McGraw Hill Pub. Co., N Delhi.
2. Wanielista, M.P. and Yousef, Y.A. (1993), “Stormwater Management”, John Wiley and Songs, Inc., New York.
3. Hall M.J. (1984), “Urban Hydrology”, Elsevier Applied Science Publishers
4. Geiger, W.F. Marsalek, J. Zudima and Rawls, G.J. (1987), “Manual on Drainage in Urban Areas”, 2 Volumes, UNESCO, Paris.

Reference Books:

1. Garg S.K., “A Text book of water supply & Sanitary Engg.”, Khanna Publishers

	COURSE CONTENTS AND LECTURE SCHEDULE	
No.		No. of Hours (48)
	Module I (9 Hours)	
1.1	Water Quantity Management: Surface Water Storage Requirements.	1

1.2	Storage Capacity and Yield.	1
1.3	Reservoir Design.	1
1.4	Water Allocations for Water Supply, Irrigation.	1
1.5	Water allocation for Hydropower and Flood Control.	1
1.6	Reservoir Operations, Planning of an Irrigation System.	1
1.7	Irrigation Scheduling, Groundwater management.	1
1.8	Conjunctive Use of Surface.	1
1.9	Subsurface Water Resources.	1
Module II (9 Hours)		
2.1	Collection and Distribution of Water: intakes.	1
2.2	Methods of water distribution.	1
2.3	Methods of Storage.	1
2.4	Flow estimation, pressures.	1
2.5	Design of networks, system maintenance.	1
2.6	Protection of water quality in systems.	1
2.7	Pumps and pumping Stations: types.	1
2.8	Characteristic curves.	1
2.9	System curves and optimal operation.	1
Module III (10 Hours)		
3.1	Aqueducts and Pipes: conveyance and distribution.	1
3.2	Stresses in pipes, pipe material, valves.	1
3.3	Corrosion.	1
3.4	Effect on water quality, and other appurtenances.	1
3.5	Types of pipes used for conveyance.	1

3.6	Pipe joints, Laying of Pipes, Distribution system.	1
3.7	Types of valves and Meters.	1
3.8	Pipe fittings and fixtures.	1
3.9	Necessity, Methods to prevent leaks.	1
3.10	Measures for conservation of water.	1
Module IV (10 Hours)		
4.1	Approaches to Urban Drainage.	1
4.2	Urban Wastes and Urban Runoff Options for Waste Disposal.	1
4.3	Separate and Combined Systems open Channels and closed Conduits.	1
4.4	Wastewater and Stormwater Reuse.	1
4.5	Elements of Drainage System Conveyance Elements, Appurtenances.	1
4.6	Overflow Structures, Runoff Control.	1
4.7	Pumping Stations. Design Parameters, Design Period.	1
4.8	Catchment, Physical Parameters.	1
4.9	Process Parameters Rainfall, Water quality Parameters.	1
4.10	Instrumentation for Data Collection.	1
Module V (10 Hours)		
5.1	Quantity of Stormwater, Stormwater Analysis.	1
5.2	Rainfall Excess and Abstractions, Calculation of Runoff Volume.	1
5.3	Peak Flow Hydrologic and Hydrodynamic methods.	1
5.4	Hydraulic Design of Conveyance Elements, Sizing of sewers and drainage Channels.	1
5.5	Design of Appurtenances, Layout of Road Drainage.	1
5.6	Layout of Pumping Stations. (illustration only)	1

5.7	Control Runoff and Pollution.	1
5.8	On-site Storage and Use of Stormwater, infiltration.	1
5.9	Detention and Retention Facilities for Stormwater Treatment.	1
5.10	Erosion Control Measures. Stormwater management models.	1

CO Assessment Questions	
CO1	Explain the methods to estimate the reservoir capacity.
CO2	Identify the methods of water intake for a conveyance system.
CO3	Explain the types of pipe used for conveyance.
CO4	Discuss about the various components in an urban drainage system.
CO5	Explain the design criteria conveyance system.

Semester 6

B.Tech (Civil Engineering) Curriculum – Semester 6

SIXTH SEMESTER												Total Marks	
Sl No	Slot	Code	Category	Title	L	T	P	J	S	Hours	Credits	CIA	ESE
1	A	24CET601	PCC	Quantity Surveying and Valuation	3	0	0	0	3	3	3	40	60
2	B	24CEJ602	PBC	Design of Structures II	2	0	2	2	5	6	5	60	40
3	C	24EST603	ESC	Computer Based Numerical Techniques	3	0	0	0	3	3	3	40	60
4	D	24CEE6X4	PEC	Professional Elective-1	3	0	0	0	3	3	3	40	60
5	E	24CEE6X5 / 24CEI6X5	PEC/ IEC	Professional Elective- 2 / Industry Elective	3	0	0	0	3	3	3	40	60
6	F	24CES606	SR	Seminar	0	0	4	0	4	4	2	100	
7	U	24SPJ607	MC	Socially Relevant Project	0	0	0	2	1	2	1*	100	
8	L	24CEL608	PCC	Environmental Engineering Lab	0	0	2	0	2	2	1	50	
9	M/H /R	24CEM609 / 24CEH609	MR/HR /RL	MINOR/HONOURS/ REMEDIAL	4	0	0	0			4/ 4/ 0	40	60
TOTAL									**24**	**26**	**21**		

X - Serial No. of Elective course in the respective basket.

Semester VI	PROFESSIONAL ELECTIVE I	Micro specialization
CEE614	PRESTRESSED CONCRETE	Gr-I
CEE624	ADVANCED CONCRETE TECHNOLOGY	Gr-II
CEE634	GEOTECHNICAL SITE INVESTIGATION	Gr-III
CEE644	MECHANICS OF FLUID FLOW	Gr-IV
CEE654	OPEN CHANNEL HYDRAULICS	Gr-IV
CEE664	ENVIRONMENTAL IMPACT ASSESSMENT	Gr-V
CEE674	TRAFFIC ENGINEERING AND MANAGEMENT	Gr-VI

Semester VI	PROFESSIONAL ELECTIVE II/ INDUSTRIAL ELECTIVE	Micro specialization
CEI615	PRE-ENGINEERED STRUCTURES	Gr-I
CEE625	HOUSING PLANNING AND MANAGEMENT	Gr-II
CEI635	CONSTRUCTION METHODS AND EQUIPMENT	Gr-II
CEI645	VALUATION OF IMMOVABLE PROPERTIES	Gr II

CEI655	REINFORCED SOIL STRUCTURES AND GEOSYNTHETICS	Gr-III
CEI675	REMOTE SENSING AND GIS	Gr-IV
CEI685	INDUSTRIAL WASTEWATER MANAGEMENT	Gr-V
CEI695	RAILWAY AND TUNNEL ENGINEERING	Gr-VI

Honours and Minor Courses

Minor in Civil Engineering

24CEM609	GEOTECHNICAL INVESTIGATION AND GROUND IMPROVEMENT TECHNIQUES

HONOURS					
BASKET 1		**BASKET 2**		**BASKET 3**	
STRUCTURAL ENGINEERING AND CONSTRUCTION MANAGEMENT		**TRANSPORTATION AND GEOTECHNICAL ENGINEERING**		**WATER RESOURCES AND ENVIRONMENTAL ENGINEERING**	
24CEH619	FUNCTIONAL DESIGN OF BUILDINGS	24CEH629	EARTH DAM AND EARTH RETAINING STRUCTURES	24CEH639	ENVIRONMENTAL POLLUTION AND CONTROL TECHNIQUES

24CET601	QUANTITY SURVEYING AND VALUATION	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course is designed to provide a structured and comprehensive framework for the study of two interconnected areas of expertise, estimation and valuation, that are essential for professionals in construction. It equips students to analyze the rate of various items of work with reference to the standard data and schedule of rate. This course develops the capability of students to prepare detailed estimates of various items of work related to civil engineering construction and also preparation of the valuation of land and buildings.

Prerequisite: 24CEL307 Civil Engineering Drawing

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Define basic terms related to estimation, quantity surveying and contract document. (Remember level)
CO2	Interpret the item of work from drawings and explain its general specification and unit of measurement. (Understand level)
CO3	Make use of given data from CPWD DAR/DSR for calculating the unit rate of different items of work associated with building construction. (Apply level)
CO4	Prepare detailed measurements (including BBS) and BoQ of various work like buildings, earthwork for road, sanitary and water supply work. (Apply level)
CO5	Explain various basic terms related to the valuation of land and building. (Understand level)
CO6	Prepare valuation of buildings using different methods of valuation. (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	2	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-
CO6	3	2	-	-	-	-	-	-	-	-	-	-

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				

Create				

Course Structure [L-T-P-J]	Attendance	Theory [L-T]			Total Marks
		Assignment	Tests-I	Tests-II	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS
Module I (Quantity Surveying - Basic terms & Terminology)
Introduction - Quantity Surveying - Basic principles, Role/responsibility of Quantity surveyor at various stages of construction. Estimate - Details required, Type of estimate, purposes. Contingencies, Work-charge establishment, Tools and Plant, centage charge, Day work, Prime cost, Provisional sum & provisional Quantity, Overhead charges, Cost index, Contract documents. (Brief description only) Bill of Quantity -Typical format-use.

Item of works - Identify various item of work from the drawings - units of measurement of various materials and works. (focus may give to RCC residential building)
General rule & method of measurement with reference to Indian Standard Specifications - IS1200.

Module II (Rates & Specifications)

Introduction to the use of CPWD schedule of rates as per latest DSR and Analysis of rate as per latest DAR.
Specifications - General specification of all items of a residential building.
Detailed specifications (CPWD specifications) of major item of work like Earth work excavation in foundation, masonry, Reinforced cement concrete, finishing of building work.
Analysis of rates for Earth work in excavation for foundation, mortars, reinforced cement concrete works, finishing work, masonry work, stone works, flooring with reference to latest DSR and latest DAR (Data should be given).

Module III (Detailed Estimate - Buildings)

Detailed Estimate - Preparation of detailed measurement using Centre line method & Short wall long wall (separate wall) method for RCC single-storied building (Flat roof) including stair cabin - Residential/office/school building.
BOQ preparation of a single-storied RCC building work.
Material quantity calculation of the items of work (Rubble, Brick work, Concrete work, Plastering) in detailed estimate prepared for building work. (Data for unit quantity should be provided from DAR)

Module IV (Detailed Estimation - Infrastructure)

Bar Bending Schedule - Preparation of BBS of RCC beams, slabs, Column footings, Retaining wall.
Road estimation - Estimation of earthwork from longitudinal section - metalled road.
Estimation of sanitary and water supply work - Water tank, Septic tank, Manhole (No Detailed estimate needed - concept of item of work, its general specification and unit of measurement).
Introduction to software tools for quantity surveying.

Module V (Valuation)

Valuation – purpose, factor affecting, introduction to terms - Value, Cost, Price, kinds of values Income - Gross income, net income, outgoings, annuity, sinking fund, Year's purchase, Depreciation, obsolescence - Free hold and leasehold properties.
Methods of calculating depreciation – straight line method – constant percentage method, sinking fund method and quantity survey method.
Methods of valuation – rental method, direct comparison of capital cost, valuation based on profit, depreciation method.
Valuation of land. (Brief description only)

Text Books:

1. B. N. Dutta, Estimation and costing in civil engineering, UBS publishers.
2. S. C. Rangwala, Estimation Costing and Valuation, Charotar publishing house Pvt. Ltd.
3. Dr. S. Seetha Raman, M. Chinna swami, Estimation and quantity surveying, Anuradha publications Chennai.

4. M. Chakraborthy, Estimating, Costing, Specification and valuation, published by the author, 21 B, Babanda Road, Calcutta 26.

Reference Books:

1. B. S. Patil, Civil Engineering contracts and estimates, university press.
2. V. N. Vazirani& S. P. Chandola, Civil Engineering Estimation and Costing, Khanna Publishers.
3. IS 1200-1968; Methods of measurement of building & civil engineering works.
4. CPWD DAR 2018 and DSR 2018 or latest.
5. CPWD Specifications Vol1 & 2 (2019 or latest edition).

Note:

For analysis of rate and cost estimation, unit rate and labour requirement should be given along with the questions in the question paper. No other charts, tables, codes are permitted in the Examination Hall. If necessary, relevant data shall be given along with the question paper.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hour (36)
Module I (8 Hours)		
1.1	Introduction to Quantity survey, basic principle, Role/responsibility of Quantity surveyor, Estimate - List the types, Details required.	1
1.2	Types of estimates, simple problems of approximate estimate, purpose.	1
1.3	Contingencies, Work-charge establishment, Tools and Plant, centage charge, Day work, Prime cost, Provisional sum & provisional Quantity. (Brief description only)	1
1.4	Bill of Quantity - Typical format – use.	1
1.5	Units of measurement of various materials and works.	1
1.6	Units of measurement of various materials and works.	1
1.7	General rule & method of measurement with reference to Indian Standard Specifications - IS1200.	1
1.8	Introduction to the use of CPWD schedule of rates as per latest DSR and Analysis of rate as per latest DAR, Overhead charges, Cost index.	1
Module II (5 Hours)		
2.1	Specifications - General specification of various items of building work.	1

2.2	Detailed specification of Earth work excavation in foundation, masonry, with reference to CPWD specifications.	1
2.3	Detailed specification of Reinforced cement concrete, finishing of building work with reference to CPWD specifications.	1
2.4	Analysis of rates for Earth work in excavation for foundation, mortars, reinforced cement concrete works, finishing work, with reference to latest DSR and latest DAR. (All data (Material, labour & machine) and rate will be given in the question paper)	1
2.5	Analysis of rates for masonry work, stone works, flooring with reference to latest DSR and latest DAR. (All data (Material, labour & machine) and rate will be given in the question paper)	1
Module III (8 Hours)		
3.1	Preparation of detailed measurement and abstract of estimate using Centre line method & Short wall long wall (separate wall) method - Explain with a single room building example.	1
3.2	Preparation of detailed measurement for RCC single storey buildings with stair cabin - Excavation for foundation, Foundation and basement, DPC, Masonry in superstructure, RCC, Plastering, Painting, flooring, Woodwork, Staircase.	1
3.3	Preparation of detailed measurement for RCC single storey buildings with stair cabin - Excavation for foundation, Foundation and basement, DPC, Masonry in superstructure, RCC, Plastering, Painting, flooring, Woodwork, Staircase. (Cont..)	1
3.4	Preparation of detailed measurement for RCC single storey buildings with stair cabin - Excavation for foundation, Foundation and basement, DPC, Masonry in superstructure, RCC, Plastering, Painting, flooring, Woodwork, Staircase. (Cont..)	1
3.5	Preparation of detailed measurement for RCC single storey buildings with stair cabin - Excavation for foundation, Foundation and basement, DPC, Masonry in superstructure, RCC, Plastering, Painting, flooring, Woodwork, Staircase. (Cont..)	1
3.6	Preparation of detailed measurement for RCC single storey buildings with stair cabin - Excavation for foundation, Foundation and basement, DPC, Masonry in superstructure, RCC, Plastering, Painting, flooring, Woodwork, Staircase. (Cont..)	1
3.7	Preparation of BoQ of single storied RCC building.	1
3.8	Material quantity calculation of the Rubble, Brick work, Concrete work, plastering in detailed estimate of RCC building. (Data for unit quantity should be provided from DAR)	1

Module IV (8 Hours)		
4.1	BBS of RCC beams.	1
4.2	BBS of RCC slabs.	1
4.3	BBS of RCC Column footings.	1
4.4	BBS of RCC Retaining wall.	1
4.5	Road estimation - Estimation of earthwork from longitudinal section - metalled road.	1
4.6	Road estimation - Estimation of earthwork from longitudinal section - metalled road.	1
4.7	Estimation of sanitary and water supply work -Water tank, Septic tank, Manhole. (Concept only)	1
4.8	Introduction to software tools for quantity surveying.	1
Module V (7 Hours)		
5.1	Valuation – Purpose, factor affecting - Introduction to terms - Value, Cost, Price, Income - Gross income, net income, outgoings, annuity, sinking fund (Simple Examples), Year's purchase.	1
5.2	Depreciation, obsolescence - Free hold and leasehold properties.	1
5.3	Depreciation – methods of calculating depreciation – straight line method, constant percentage method.	1
5.4	Sinking fund method, and quantity survey method - numerical examples.	1
5.5	Methods of valuation of land with building – rental method, direct comparison of capital cost.	1
5.6	Valuation based on profit, depreciation method.	1
5.7	Various method of valuation of land. (Brief description only)	1

CO Assessment Questions	
CO 1	Explain the terms (a) Cost index (b) Overhead charges.
CO 2	Reproduce the detailed specification for earthwork excavation for foundation.
CO 3	Develop unit rate of the work (DSR 2018 item No. 4.1.2), providing and laying in position 1:1½:3 (1 Cement: 1½ coarse sand (zone-III) : 3 graded stone aggregate 20 mm nominal size) cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : MATERIAL : 0.57cu.m 20mm nominal size of stone aggregate @ Rs.1370/cu.m., 0.28cu.m 10mm nominal size of stone aggregate @

	Rs.1350/cu.m., 0.425 cu.m of coarse sand (Zone-III) @Rs.1350/cu.m., 0.2833cu.m Portland cement @ Rs.4940/tonne, LABOUR : 0.10 Mason @ Rs.709/day; 1.63 Beldar @ Rs.558/day, 0.70 Bhisti @ Rs.617/day. CARRIAGE PROVISIONS: Stone aggregate below 40mm Rs. 103.77/cu.m.; coarse sand @Rs.103.77/cu.m. and for cement @ Rs.92.24/tonne. HIRE CHARGES of concrete mixer 0.07@Rs.800/day, Vibrator 0.07@Rs.370/day, SUNDRIES, LS, 14.30@Rs.2.
CO 4	A simply supported beam of size 450 x 230 having a span of 6m is supported on a 30cm wall at both ends. The stirrups of 10mm diameter are provided at a spacing of 150mm c/c. The beam have main bar of 3 no's 20mm diameter at bottom including one bend up bar and stirrup holders are of 2 no's 16mm diameter at top. Main & Stirrup holder reinforcement is provided with a cover of 25mm. Calculate the total quantity of the reinforcement required for the stirrup for this beam. Also prepare an estimate of tor steel reinforcement for stirrup including cutting, bending, placing in position and binding, adopt the rate as Rs.95/kg.
CO 5	Explain how depreciation in building is worked out.
CO 6	Workout the valuation of a commercial building with the following data: Cost of land for life-time period of building is ₹.5,20,000/-. Gross income per year is ₹.8,50,000/-Expenses required per year: (a) staff salary, electric charges, municipal taxes including licenses fees, stationery and printing etc. is 20% of the gross income. (b) For repair and maintenance of lift, furniture etc. @ 5% of their capital cost of ₹.10,50,000/- (c) sinking fund for the items considered in capital cost, whose life is 25years @4% after allowing 10% scrap value. (d) Insurance premium is ₹.25,000/- per year. Take year's purchase @8% and annual repair of the building @2% on gross income.

24CEJ602	Design of Structures II	L	T	P	J	S	C	Year of Introduction
		2	0	2	2	5	5	2024

Preamble: This course equips students with the fundamental concepts of the design of steel structures. Additionally, this course exposes students to the concepts of earthquake resistant design and trains them to use different software tools needed for the analysis and design of steel and RCC structural elements. As the students undertake academic projects as part of the course, they will be well-prepared for a successful career in structural design.

Prerequisite: 24CEP504 Design of Structures I

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

CO1	Explain the criteria for earthquake-resistant design of structures and the ductile detailing of concrete structures subjected to seismic force. (Understand level)
CO2	Design bolted and welded connections. (Apply level)
CO3	Design tension members, compression members, column bases and beams using the IS specifications. (Apply level)
CO4	Assess loads on truss and design purlins using IS specifications. (Apply level)
CO5	Perform analysis and design of multi-storeyed framed structure using a software. (Apply level)
CO6	Prepare detailed structural drawings of RC members using a software. (Apply level)
CO7	Design a multi storeyed/ industrial building and prepare structural drawings. (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	2	-	-	-	-	-	-
CO3	3	3	3	-	-	2	-	-	-	-	-	-
CO4	3	3	3	-	-	2	-	-	-	-	-	-
CO5	3	3	3	-	3	2	-	2	-	2	-	-
CO6	3	-	-	-	3	-	-	2	-	2	-	-
CO7	3	3	3	2	3	2	-	3	3	3	-	2

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember		✓	✓	✓
Understand		✓	✓	✓
Apply		✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab component		
Bloom's Category	**Continuous Assessment Tools**	
	Class work	**Test1**
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create		

Assessment Pattern for Project Component			
Bloom's Category	**Continuous Assessment Tools**		
	Evaluation 1	**Evaluation 2**	**Report**
Remember			
Understand	✓	✓	
Apply	✓	✓	
Analyse	✓	✓	
Evaluate		✓	
Create			

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]		Practical [P]	Project [J]			Total Marks
		Assignment	Test-2	Class work	Evaluation 1	Evaluation-2	Report	
2-0-2-2	5	10	15	10	5	10	5	60

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	**60**	**40**	**2.5**

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks.	

		Marks: (5×8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5×8 = 40 marks]	

SYLLABUS
MODULE I (Limit state of serviceability, Introduction to earthquake-resistant design)
Limit state of serviceability, Introduction to earthquake-resistant design. Importance of Ductility in Seismic Design, Major Design Considerations, Codal provisions – IS 1893, IS 13920.
MODULE II (steel structures - Connections)
Introduction to steel and steel structures, Properties of structural steel and types of Structural steel sections, limit state design concept, Bolted and Welded connections.
MODULE III (Tension members)
Tension members, Types of sections net area -Design of tension members, concept of shear lag, Lug angle.
MODULE IV (Compression members)
Compression Members-Design of Struts, Solid and Built-up Columns for axial load, design of battens and lacing, Column Bases-slab base and gusset base.
MODULE V (Beams and Roof Truss)
Introduction- Beams, design of Laterally restrained and Laterally Unrestrained beams, Design of compound beams, Plate girder, and Gantry girder (Introduction only- No design), Type of roof truss - design loads and load combinations, Calculation of wind loads, Design of purlins.
Text books 1. Pillai, S.U & Menon, D., Reinforced Concrete Design, Tata McGraw Hill Book Co., 2009. 2. Duggal, S.K., Limit State Design of Steel Structures, Mc Graw Hill Publications.
Reference books 1. Ramachandra S., Design of Steel Structures - Standard Book House, Delhi, 1984. 2. Subramanian N., Design of Steel Structures, Oxford Publications. 3. SP 6 Part 1: 1964 (Reaffirmed 2003), Handbook for structural engineers - 1. Structural steel sections. 4. Dayaratnam P., Design of Steel Structures, Oxford and IBH Publishing Co. 5. SP 34 Handbook on concrete reinforcement and detailing, Code of Practice, Bureau of Indian Standards. 6. IS 13920: 2016, Ductile design and detailing of reinforced concrete structures subjected to seismic forces – Code of Practice, Bureau of Indian Standards, New Delhi.

7. IS 800: 2007, Code of Practice for use of Structural Stee in General Building Construction, Bureau of Indian Standards, New Delhi.
8. IS 875 Part 3- 2015 Design loads for buildings Part 3: Wind loads, Bureau of Indian Standards, New Delhi.
9. IS 1893: 2016, Criteria for Earthquake resistant design of structures, Bureau of Indian Standards, New Delhi.
10. AutoCAD Essentials, Autodesk Official Press, John Wiley & Sons, US, 2015.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (24)
	MODULE 1 (4 Hours)	
1.1	Limit state of serviceability - limit state of deflection- short-term and long-term deflection.	1
1.2	Limit state of serviceability - IS code recommendations- limit state of cracking- estimation of crack width- simple numerical examples.	1
1.3	Introduction to earthquake resistant design, Importance of Ductility in Seismic Design.	1
1.4	Major Design Considerations, Codal provisions – IS 1893, IS 13920.	1
	MODULE II (6 Hours)	
2.1	Introduction to steel and steel structures, Properties of structural steel and types of Structural steel sections.	1
2.2	Bolted Connection – different types. (lap Joint and Butt Joint)	1
2.3	Design of bolted joints – numerical examples.	1
2.4	Eccentric bolted connection – beam-to-beam connection.	1
2.5	Welded connection – different types, design of welded connection.	1
2.6	Eccentric welded connection – beam-to-beam connection.	1
	MODULE III (4 Hours)	
3.1	Introduction, Types of tension members, Modes of failure, net area calculation.	1
3.2	Factors affecting strength of tension members, Concept of shear lag.	1
3.3	Design of tension members.	1
3.4	Design of tension members (numerical Example), lug angle (concept only).	1
	MODULE IV (5 Hours)	
4.1	Introduction-compression members, Design of struts.	1
4.2	Solid and built-up columns for axial loads alone.	1

4.3	Design of lacing system.	1
4.4	Design of battening system.	1
4.5	Column base plate introduction- Simple slab base plate-only axial load, Gusseted base-only axial load.	1
MODULE V (5 Hours)		
5.1	Introduction- Beams, design of Laterally restrained beams.	1
5.2	Design of Laterally Unrestrained beams.	1
5.3	Design of compound beams, Plate girder and Gantry girders (introduction only- No design).	1
5.4	Type of roof truss-design loads and load combinations, Calculation of wind loads.	1
55	Design of purlins.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours [24]	Experiment
1	Analysis and design of steel and RCC elements using any standard software used in the industry.	2	Analysis and design of continuous and cantilever beams.
		2	Analysis and design of plane truss and frames.
		2	Analysis and design of multi-storied RCC framed structures.
2	Preparation of structural drawings of slabs and beams Preparation of structural drawings of slabs and beams	2	Detailed structural drawing of one-way/two-way slabs.
		2	Detailed structural drawing of continuous slabs.
		2	Detailed structural drawing of singly reinforced beams.
		2	Detailed structural drawing of double reinforced beams.
		2	Detailed structural drawing of continuous beams.
		2	Detailed structural drawing of flanged beams.
		2	Detailed structural drawing of foundation units – isolated footing.
		2	Detailed structural drawing of foundation units – combined footing (rectangular).

2	Lab Exam	2	Lab exam

COURSE PROJECT

Sample project topics for students to work on:

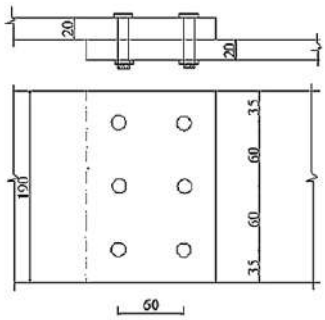
1	Design a multi-storeyed building according to IS codes using any standard software used in the industry.
2	Design an industrial building according to IS codes using any standard software used in the industry.

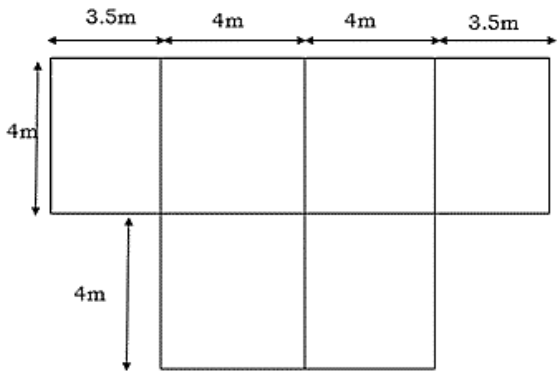
Note:- Projects need not be restricted to the above topics. Students are encouraged to choose any application problems, in the course domain, which they desire to work on.

LESSON PLAN FOR PROJECT COMPONENT

No.	Topic	No. of Class Hours[24]
1	Preliminary Design of the Project	4
2	Zeroth presentation (4th week)	2
3	Project work - First Phase	4
4	Interim Presentation (7th and 8th weeks)	4
5	Project work - Final Phase & Report writing (discussions in class during project hours)	6
6	Final Evaluation and Presentation (11th and 12th weeks)	4

CO Assessment Questions	
1	1. Enumerate the objectives of earthquake-resistant design of reinforced concrete structures. 2. Explain the objectives behind the special detailing provisions in IS 13920. 3. Discuss the term special confining reinforcement in columns of ductile frames. 4. Explain the design requirements of beam-column joints in earthquake-resistant design.
2	1.Two plates 10 mm and 20 mm thick are to be jointed by double cover butt joint. Design the joint for the following data. Axial load 500 kN, Bolt diameter 18 mm, Grade of steel Fe 410, Grade of bolts 4.6. 2. Find the efficiency of the lap joint shown in Figure 1. Given M20 bolts of grade 4.6 and Fe 410 plates. All dimensions are in mm.

	 Figure 1 3. Design a lap joint between the two plates of width 150 mm, if the thickness of one plate is 12 mm and the other is 10 mm. The joint has to transfer a working load of 100 kN. The plates are of Fe 410 grade. Use bearing type bolts.
3	1.Design a tension member 3.5 m between c/c of intersections, using double angle section and carrying a factored pull of 350 kN. Two angles are placed on either side of a 12 mm thick gusset plate. The member is subjected to reversal of stresses 2. Design a welded single-angle tension member to carry a tensile load of 200 kN. The angle is connected to a 10 mm thick gusset plate. 3. Design a column 7 m long to carry a factored axial load of 1100 kN. The column is restrained in position but not in rotation at both ends. Design a laced system for the column. Assume that the two channels are kept back-to-back. 4. A column 4.2 m long has to support an axial load of 4000 kN. The column is fixed at one end and other end is hinged. Design the column using rolled steel sections and plates. 5. A steel floor beam in a building has a span of 6 m. It is simply supported over supports and carries a uniform load of 40 kN/m, inclusive of self-weight. Design the beam (Fe 410 steel) if the compression flange is restrained throughout the span against lateral bending.
4	1.Design a purlin on a sloping roof truss with the dead load of 0.15 kN/m2, a live load of 2.5 kN/m^2 and a wind load of 0.6 kN/m^2 (suction). The purlins are 1.9 m centre to centre and a span of 4 m, simply supported on a rafter at a slope of 200. 2. Determine the design wind pressure on a pitched roof near Delhi. Given Structure: An industrial shed situated on flat terrain with sparsely populated buildings. The span of roof truss is 20 m and rise is 4 m Height of building at eaves: 10 m.
5	Analyze the two-storey RCC framed structure shown below (Plan) using STAAD software • Height of each storey: 3.5 m • Occupancy type: Business and Office Building (Refer IS 875 Part 1 & 2)

<table>
<tr><td></td><td> 
</td></tr>
<tr><td>6</td><td>Prepare a detailed structural drawing of continuous beam 230 mm x 500 mm for a clear span of 5 m. The beam is supported on columns having dimension 230 mm X 230 mm. The slab thickness is 120 mm. The reinforcement details for the beam is shown below
<table>
<tr><td>At bottom</td><td>3# 20 Φ @ mid span, 1 bar curtailed near support</td></tr>
<tr><td>At top</td><td>3# 20 Φ @ supports, 1 bar curtailed towards centre</td></tr>
<tr><td>Stirrups at Mid span</td><td>2L-#8 at 175 c/c</td></tr>
<tr><td>Stirrups at supports</td><td>2L-#8 at 125 c/c</td></tr>
</table></td></tr>
<tr><td>7</td><td>1. Design a multi-storeyed building according to IS codes using any standard software used in the industry.
2. Design an industrial building according to IS codes using any standard software used in the industry.</td></tr>
</table>

24EST603	COMPUTER BASED NUMERICAL TECHNIQUES	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course serves as an introduction to the prevalent numerical techniques employed in Civil Engineering. It provides an overview of a range of numerical methods essential for tasks such as solving linear and nonlinear equations, ordinary and partial differential equations, interpolation, integration and lays the groundwork for understanding the Finite Element Method. By the end of the course, students will acquire a thorough understanding of a variety of numerical methods for tackling mathematical challenges, empowering them to develop corresponding computer programs.

Prerequisite: Nil

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

CO1	Describe and apply basic numerical methods to obtain approximate solutions of mathematical problems. (Understand and Apply level)
CO2	Obtain numerical solution of linear and nonlinear algebraic equations using a computer programme. (Apply level)
CO3	Perform numerical integration using a computer programme. (Apply level)
CO4	Numerically solve differential equations using a computer programme. (Apply level)
CO5	Explain the terminology, techniques or procedures employed in the Finite Element Method. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	3	-	-	-	-	-	-	1
CO3	2	-	-	-	3	-	-	-	-	-	-	1
CO4	2	-	-	-	3	-	-	-	-	-	-	1
CO5	2	-	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Linear and Nonlinear Equations)

Introduction to numerical methods - Errors in numerical computation.

System of linear algebraic equations – Ill-conditioned systems – Symmetric and Banded systems. Gauss Elimination (review), Gauss Seidel iteration, LU Decomposition method.

System of non-linear equations – Newton-Raphson method.

Eigen value problems - largest and smallest eigen values - Power method.

MODULE II (Approximation, Data smoothening and Integration)

Approximation - Lagrangian and Hermite interpolation, Spline interpolation - Quadratic and Cubic splines (example of equal intervals).

Data smoothing by least squares criterion- non-polynomial models like exponential model and power equation, Multiple linear regression.

Numerical integration - Newton–Cotes open quadrature formulae, Trapezoidal rule,

Simpson's rules (Review).

MODULE III (Ordinary Differential Equations)

Solution of first-order ordinary differential equations - stability of solution, Use of Taylor series, Euler's method, Modified Euler's method, Fourth order Runge-Kutta method.
Higher order equations of initial value type by Runge-Kutta method.
Ordinary differential equations of the boundary value type – Finite difference solution.

MODULE IV (Partial Differential Equations)

Partial differential equations in two-dimension - types, Laplace Equation and Poisson's equation.
Parabolic equations – Explicit finite difference method – Bender-Schmidt method. Crank-Nicholson implicit method.
Elliptic equations - Finite difference method.

MODULE V (Introduction to FEM)

Weighted residual methods for initial value problems and boundary value problems – Collocation method, Method of least squares, Galerkin's method.
Introduction to FEM – Applications - Concept of Nodes, Elements, Types of elements - element properties.
Outline of the FEA procedure – Displacement approach - Concept of Stiffness Matrix, Shape function - convergence requirements, equilibrium and compatibility in the solution - boundary conditions.
Conceptual ideas of finite volume, boundary element and meshless methods.
Introduction to FEAST^{SMT} Software.

Text books

1. Grewal B. S., Numerical Methods for Engineers & Scientists, Khanna Publishers.
2. Rajasekharan S., Numerical Methods in Science and Engineering, S Chand & Company, 2003.

Reference books

1. Gerald and Wheatly, Applied Numerical Analysis, Pearson Education.
2. Chapra S. C. and R. P. Canale, Numerical Methods for Engineers, McGraw Hill, 2006.
3. Smith G. D. Numerical solutions for Differential Equations, McGraw Hill.
4. Ketter and Prawel, Modern Methods for Engineering Computations, McGraw Hill.
5. Rajasekharan S., Numerical Methods for Initial and Boundary value problems, Khanna Publishers, 1989.
6. Terrence. J. Akai, Applied Numerical Methods for Engineers, Wiley Publishers, 1994.
7. Krishnamoorthy C S, Finite Element Analysis- Theory and Programming, Tata McGraw Hill, New Delhi., 1994.
8. Bathe K J, Finite Element Procedures in Engineering Analysis, Prentice Hall, New Delhi. 1982.
9. Chandrupatla T R and Belegundu A D, Introduction to Finite Elements in Engineering, Pearson Education, New Delhi 1998.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
MODULE 1 (8 Hours)		
1.1	Introduction to numerical methods - Necessity, Errors in numerical computation.	1
1.2	System of linear algebraic equations, Ill-conditioned systems, Symmetric and Banded systems.	1
1.3	Direct and indirect methods of solution of linear equations: Gauss elimination method(review), Gauss Siedal iteration.	1
1.4	Factorization method- LU Decomposition.	1
1.5	Problems on solution of linear equations.	1
1.6	System of non-linear equations – Newton-Raphson Method.	1
1.7	Eigen value problems, Power method-largest & smallest Eigen values.	1
1.8	Problems on Power method.	1
MODULE II (7 Hours)		
2.1	Approximation - Lagrangian and Hermite interpolation.	1
2.2	Spline interpolation - Quadratic and Cubic splines.	1
2.3	Problems on interpolation.	1
2.4	Data smoothing by least squares criterion - non-polynomial models like exponential model, power equation.	1
2.5	Multiple linear regression.	1
2.6	Numerical integration- Newton – Cotes open quadrature, Trapezoidal rule, Simpson's rules (Review).	1
2.7	Problems on numerical integration.	1
MODULE III (8 Hours)		
3.1	Solution of first-order ordinary differential equations - stability of solution.	1
3.2	Solution of first-order ordinary differential equations by use of Taylor series.	1
3.3	Euler's method.	1
3.4	Modified Euler's method.	1

3.5	Fourth order Runge-Kutta method - Problems.	1
3.6	Problems on solution of ODEs.	1
3.7	Higher order equations of initial value type by Runge-Kutta method.	1
3.8	ODE-BVP - Finite difference solution.	1
MODULE IV (5 Hours)		
4.1	Partial differential equations in two-dimension - types, Laplace Equation and Poisson's equation.	1
4.2	Parabolic equations – Explicit finite difference method -Schmidt method.	1
4.3	Crank-Nicholson implicit method.	1
4.4	Elliptic equations- Finite difference method.	1
4.5	Numerical Problems.	1
MODULE V (7 Hours)		
5.1	Weighted residual methods for initial value problems and boundary value problems – Collocation method.	1
5.2	Method of least squares, Galerkin's method.	1
5.3	Introduction to FEM – Applications - Concept of Nodes, Elements, Types of elements - element properties.	1
5.4	Outline of the FEA procedure, Displacement approach - Concept of Stiffness Matrix.	1
5.5	Shape function - convergence requirements, equilibrium and compatibility in the solution - boundary conditions.	1
5.6	General awareness on finite volume, boundary element and mesh less methods and their difference with FEM.	1
5.7	Introduction to FEAST^{SMT} Software (Demonstration)	1
5.8	Introduction to FEAST^{SMT} Software (Demonstration)	1

CO Assessment Questions	
CO1	1. Explain the procedure of Euler's method for solving ordinary differential equations. 2. Solve the following system of equations using Gauss elimination method. 4x+y+z =4 x+4y-2z = 4 3x+2y-4z = 6

	3. Consider the initial value problem y'= x (y + x) – 2, y(0) = 2. Find y(0.4) using Eulers method with step size h=0.1. 4. Solve the one-dimensional heat equation: $\partial u/\partial t = \alpha * \partial^2 u/\partial x^2$ in the domain $0 \le x \le 1$ using finite difference method with Initial condition: u(x, 0) = 4x(1 - x) and Boundary conditions: u(0, t) = 0 and u(1, t) = 0. Given Thermal diffusivity: $\alpha = 0.1$.
CO2	Write computer programs to solve the given system of linear equations using i)Gauss Elimination Method ii) Gauss Seidel Iteration Method.
CO3	Consider integration of the function f(x) = sin(x) over a fixed interval [0, π/2], Write a program to integrate the function using a) Trapezoidal rule b) Simpson's rule taking the number of points 5, 11 and 21. Compare your result with the exact value of the integral.
CO4	Write computer programs to solve the given ordinary differential equation using i)Eulers Method ii) Taylor Series Method iii) Runge -Kutta Method.
CO5	1. Explain the general procedure of the Finite Element Analysis (FEA) for solving engineering problems. 2. Discuss the advantages and limitations of the Finite Element Method as a numerical analysis technique in engineering applications. 3. Discuss the concept of shape functions in the Finite Element Method. How are they used to interpolate the solution within each element?

24DCS606	SEMINAR	L	T	P	J	S	C	Year of Introduction
		0	0	4	0	4	2	2024

Preamble: The course is intended to enable students to read, understand, present and prepare report about academic documents. The learner shall search in the literature including peer reviewed journals, conference proceedings, books, project reports etc., and identify appropriate papers in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about selected academic documents and also empower her/him to prepare a technical report.

Prerequisite: Nil

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

CO 1	Identify academic documents from the literature which are related to her/his areas of interest. (Apply Level)
CO 2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest. (Analyse Level)
CO 3	Prepare a presentation about an academic document. (Create Level)
CO 4	Show a presentation on the academic document (Apply Level)
CO 5	Prepare a technical report. (Create Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	2	-	-	-	-	-	-	-	2
CO2	-	-	-	3	-	-	-	-	-	-	-	3
CO3	-	-	-	1	-	-	-	3	-	3	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	-
CO5	-	-	-	1	-	-	-	3	-	3	-	-

Assessment Pattern

Bloom's Category	Continuous assessment tools	
	Presentation 1	Presentation 2
Remember		
Understand		
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create	✓	✓

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Seminar [SR]**			**Total Marks**
		Guide	**Technical content**	**Presentation**	
0-0-4-0	5	25	30	40	**100**

Total Mark distribution	
Total Marks	**CIA (Marks)**
100	100

General guidelines

- The report and the presentation shall be evaluated by a team of internal members comprising three senior faculty members based on the style of presentation, technical content, adequacy of reference, depth of knowledge and overall quality of the report.
- Guide shall provide required input to their students regarding the selection of topic/paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

24SPJ607	SOCIALLY RELEVANT PROJECT	L	T	P	J	S	C	Year of Introduction
		0	0	0	2	1	1	2024

Preamble: The main purpose of Socially Relevant Projects is to make students understand their social commitments through projects which benefits both the institution as well as the society. The community will benefit from the focused contribution of students towards local development, and at the same time, the institution provides an opportunity for students to develop social sensibility and responsibility. After the completion of the course, the students will be able to think critically and creatively about social issues, and to develop innovative solutions to address them.

Prerequisite: Nil

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

CO1	Interpret socially relevant problems. (Apply level)
CO2	Analyse the problems using surveys and research. (Analyse Level)
CO3	Suggest technical solutions to the identified problems using relevant state of the art technologies. (Evaluate and create level)
CO4	Prepare a technical report. (Create level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-		-	-	-	-	3	-	-	-
CO2	2	2	-	3	-	-	-	-	3	-	-	-
CO3	3	2	-	2	-	-	-	3	3	3	-	-
CO4	-	-	-	-	-	-	-	3	3	3	-	-

Assessment Pattern

Bloom's Category	Continuous assessment tools	
	Evaluation 1	Evaluation 2
Remember		
Understand		
Apply	✓	✓
Analyse	✓	✓
Evaluate		✓
Create		✓

Mark Distribution of CIA						
Course Structure [L-T-P-J]	**Log book**	**Final Evaluation [MC]**			**Report**	**Total Marks**
0-0-0-2	**25**	**Objectives**	**Execution Process**	**Presentation**		
		10	**25**	**15**	**25**	**100**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	100	-	-

General guidelines

- **Activities for Socially Relevant Project**
  - ❖ Conducting surveys and research on social issues and concerns to gain a better understanding of the problem and identify potential solutions.
  - ❖ Developing and implementing educational programs to promote awareness and understanding of social issues and concerns.
  - ❖ Collaborating with local NGOs and community groups to organize events and activities that promote social welfare and community development.
  - ❖ Developing and implementing social welfare programs that address the needs of marginalized and vulnerable communities, such as homeless individuals, refugees, and low-income families.
  - ❖ Conducting community service activities, such as volunteering at local shelters, food banks, and community centers.
  - ❖ Developing and implementing environmental conservation programs that promote sustainable practices and reduce the impact of human activities on the environment.
  - ❖ Creating and distributing educational materials, such as pamphlets and brochures, to raise awareness about social issues and concerns.
  - ❖ Organizing fund raising events to support social welfare programs and community development initiatives.
  - ❖ Engaging in advocacy and lobbying efforts to influence public policy and promote social justice.

- **Implementation of Socially Relevant Project**
  - ❖ Each student should complete a minimum of 60 hours of community service during their lower semesters (1-5).
  - ❖ Assign a group of students or a single student to a particular habitation, village, or municipal ward in the near vicinity of their place of stay.

- ❖ Each team should be assigned with a mentor to guide them through the process.
- ❖ The project can be any socially prevailing issue related to water and sanitation, environment, energy, ecology, health care, housing, differently abled, irrigation, disaster management, mines and geology, agriculture, sustainability, heritage, educational and entrepreneurship etc.
- ❖ Each student shall keep a log book of their activities, which must be signed by their mentor or faculty member in charge.
- ❖ The participation of students in NSS/NCC/Club activities will not be coming under the purview of socially relevant projects.
- ❖ Each team shall submit a report and make a brief presentation based on the service rendered to the society, and an evaluation will be conducted by a committee constituted by the Head of the Department.

- **Procedure for doing Socially Relevant Project**
  - ❖ Conduct a survey of the habitation to gain a better understanding of the social issues and concerns that need to be addressed. A common survey format could be designed to ensure consistency.
  - ❖ Develop a project work related to the student's domain or subject area that addresses the identified social issues and concerns. The project should be designed to be socially relevant and have a positive impact on the community.
  - ❖ Implement the project work with the help of the local community and relevant authorities. This could include organizing awareness programs, developing and implementing educational programs, conducting community service activities, and engaging in advocacy and lobbying efforts.
  - ❖ Monitor and evaluate the project work to ensure that it is having the desired impact on the community. This could include conducting surveys and research, gathering feedback from the local community, and tracking key performance indicators.
  - ❖ Document the project work and its impact on the community, and share the findings with relevant stakeholders, including the local community, government authorities, and academic institutions.

- **Time frame for the socially relevant project**
  - ❖ Duration: 8 weeks
  - ❖ Schedule:
  - ❖ Socio-Economic Survey of the village / habitation (Two weeks): A group of students under the guidance of faculty mentors conduct a socio-economic survey of the village / habitation. They will interact with people to acquire

basic knowledge on the project to be chosen for study and conduct the survey using a structured questionnaire.

- ❖ Community awareness campaign (One week): The student group takes up community awareness campaigns based on the above survey conducted by identifying the problems or vulnerable issues. They may also conduct house-to-house campaign on socially relevant theme. Eg: Government welfare programs, health care, consumer protection, food adulteration, digital transactions, information sources etc.
- ❖ Main project (4 weeks): A group of students chose a topic related to their subject area and conduct a project which includes data collection, interviews, internship in any selected unit or department and suggesting solution for the problem identified.
- ❖ Report preparation (1 week): The student should submit a project report duly signed by the mentor.

- **Evaluation pattern**
  - ❖ There will be only internal evaluation for this project.
  - ❖ Each faculty member is to be assigned with five student groups. The faculty member will act as a faculty mentor for the group and is in charge for the learning activities of the students and also for the comprehensive and continuous assessments of the students.
  - ❖ The assessment is to be conducted for 100 marks. The weightage shall be:
    - Project log book: 25%
    - Project implementation: 50%
      (10% for objectives, 25% for execution/proposal and 15% for presentation).
    - Project report: 25%
  - ❖ While grading the student's performance using the student's project log, the following should be taken into account:
    - Individual student's effort and commitment.
    - Originality and quality of the work produced by the individual student.
    - Integration and co-operation with the work assigned.
    - The completeness of the log book.
  - ❖ Assessment for project implementation:
    - Orientation to the community development.
    - Conducting a baseline assessment of development needs.
    - Number of awareness programs and participants for each.
    - Number of intervention programs and participants for each.
    - Number of follow-up programs and participants for each.
    - Developing short-term and mid-term action plans in consultation with local leadership and local government officers.
  - ❖ Assessment for project presentation:

- Assessing the involvement in the project.
- Presentation skills.
- Final outcome of the project.

❖ Assessment for project report.

Note: Final Evaluation of the project should be done by a three-member Committee - (Mentor shall be one member in the CIE committee).

24CEL608	ENVIRONMENTAL ENGINEERING LAB	L	T	P	J	S	C	Year of Introduction
		0	0	2	0	2	1	2024

Preamble: The course intents to impart hands-on-training for the analysis of water and wastewater and to certify the samples for drinking purposes in accordance with BIS standards. This course covers the analysis of physical, chemical and biological characteristics of water. This course enables the students to recommend the appropriate treatment methods for water and wastewater systems.

Prerequisite: 23CET503 Environmental Engineering

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

CO1	Analyse the quality of water and wastewater (Apply and Analyse level)
CO2	Evaluate the suitability of water for drinking purposes (Apply level)
CO3	Recommend the appropriate treatment methods for water and wastewater (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	2	-	3	3	3	-	1
CO2	2	-	-	-	-	3	-	-	-	-	-	-
CO3	2	-	-	-	-	2	-	-	-	2	-	1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools	
	Class work	Test
Remember		
Understand	✓	✓
Apply	✓	✓
Analyse	✓	✓
Evaluate		
Create		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Practical		Total Marks
		Class work	Lab Exam	
0-0-2-0	5	35	10	50

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
50	50	-	-

SYLLABUS
Analysis of physical characteristics of water: pH, turbidity, conductivity – Analysis of chemical characteristics of water and waste water: Solids, Dissolved Oxygen, Optimum coagulant dosage, Biochemical Oxygen Demand, Chemical Oxygen Demand, Available chlorine, Chlorine Demand, Sulphates, Nitrates, Iron, Emerging contaminants (Microplastics) – Analysis of bacteriological characteristics of water: Total Coliforms.

List of Experiments	
1.	Determination of pH, Turbidity and Conductivity.
2.	Determination of Solids.
3.	Determination of Dissolved Oxygen.
4.	Determination of Optimum Coagulant Dose.
5.	Determination of Biochemical Oxygen Demand and Chemical Oxygen Demand.
6.	Determination of Available Chlorine.
7.	Determination of Chlorine Demand.
8.	Determination of Sulphates and Nitrates.
9.	Determination of Iron.
10.	Determination of Microplastics.
11.	Determination of Total Coliforms.
Minimum 10 experiments are mandatory.	

Reference

1. Standard Methods for the examination of water and waste water, American Public Health Association.
2. IS 10500:2012 Drinking Water – Specification, Bureau of Indian Standards, New Delhi.

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Analysis of physical characteristics of water	2	Determination of pH, Turbidity and Conductivity
2	Analysis of chemical characteristics of water and waste water	2	Determination of Solids
3		2	Determination of Dissolved Oxygen
4		2	Determination of Optimum Coagulant Dose
5		2	Determination of Biochemical Oxygen Demand and Chemical

			Oxygen Demand
6		2	Determination of Available Chlorine
7		2	Determination of Chlorine Demand
8		2	Determination of Sulphates and Nitrates
9		2	Determination of Iron
10		2	Determination of Microplastics
11	Analysis of bacteriological characteristics of water	2	Determination of Total Coliforms
12	Exam	2	Lab exam

PROFESSIONAL ELECTIVE – 1

24CEE614	PRESTRESSED CONCRETE	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The main objective of this course is to expose the students the fundamental concepts of prestressed concrete as well as the analysis and design of various prestressed concrete elements using IS Code provisions. This course covers the strength, stiffness and stability aspects of prestressed concrete members. This course will make the students to familiarise with the concepts and design of typical pre-stressed concrete structural elements and have a knowledge of the codal provisions.

Prerequisite: 24CEP504 Design of structures I

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

CO1	Analyse prestressed concrete members and estimate the losses in prestress. (Apply level)
CO2	Design of prestressed concrete member for flexure using codal provisions. (Apply level)
CO3	Design for shear and torsion of prestressed concrete members. (Apply level)
CO4	Design of end blocks and provide detailing of reinforcements. (Apply level)
CO5	Design of composite members and other applications. (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	-	-	-	-	-	-	-	-
CO2	3	2	3	-	-	-	-	2	-	-	-	-
CO3	3	2	3	-	-	-	-	2	-	-	-	-
CO4	3	2	3	-	-	-	-	2	-	-	-	-
CO5	3	2	3	-	-	-	-	2	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			
		Assignment	**Test-1**	**Test-2**	**Total Marks**
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question, 2 questions from each module, each carries 3 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (8×5 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Introduction)

Review - Basic concept and principles of pre-stressed concrete, materials, prestressing systems – Analysis of prestress and bending stresses. Losses in prestress: Immediate losses - time dependent losses - total losses.

MODULE II (Analysis and design of flexural members)

Limit state design criteria: Inadequacy of elastic and ultimate load method, criteria for limit states, strength and serviceability. Design for flexure: Modes of failure in flexure - ultimate moment of resistance of sections with bonded tendons - strain compatibility method - IS code procedure.

MODULE III (Design for shear and torsion)

Design for shear and torsion: Effect of prestress in shear strength - zones for shear design – shear resistance of sections - design for shear - failure modes in torsion - design for torsion.

MODULE IV (Deflection and Anchorage Zone)

Deflections of prestressed concrete members: Deflection in type I and type II beams - short term and long term deflections – IS code procedures.

Design of anchorage zones: Anchorage zones in pre-tensioned members - development length – end zone reinforcement - anchorage zones in post-tensioned members - bearing stresses - bursting forces - end zone reinforcement.

MODULE V (Composite sections and Indeterminate structures)

Composite members: Analysis at serviceability limit state - stresses due to differential shrinkage - ultimate moment of resistance.

Indeterminate structures: Primary and secondary moments and shears - effective cable line – linear transformation of cable profile - concordant cable - analysis of sections.

Text books

1. Pandit G S & S P Gupta, “Prestressed Concrete”, CBS Publishers, 2014.
2. Krishna Raju N, Prestressed concrete, Tata McGraw Hill Company, New Delhi 1998.
3. Rajagopalan, N, “Prestressed Concrete”, Alpha Science, 2002.

Reference books

1. Lin T Y, Design of prestressed concrete structures, Asia Publishing House, Bombay 1995.
2. Praveen Nagarajan, Prestressed Concrete Design, Pearson,2013.
3. Mallic S K and Gupta A P, Prestressed concrete, Oxford and IBH publishing Co. Pvt. Ltd., 1997.
4. Ramaswamy G S, Modern prestressed concrete design, Arnold Heinimen, New Delhi, 1990.
5. Relevant BIS codes.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (35)
	MODULE I (7 Hours)	
1.1	Introduction to various types of PSC members. Brief history of prestressing, advantages and limitations of prestressing.	1
1.2	Types of prestressing, prestressing systems and devices, Concrete and steel used in prestressed concrete, losses in prestress.	1
1.3	Types of prestressing, prestressing systems and devices, Concrete and steel used in prestressed concrete, losses in prestress.	1
1.4	Basic concepts of prestressing- Stresses at transfer and service loads.	1
1.5	Basic concepts of prestressing- Stresses at transfer and service loads.	1
1.6	Losses in prestress-Numerical.	1
1.7	Losses in prestress-Numerical.	1
	MODULE II (7 Hours)	

2.1	Limit state design criteria: Inadequacy of elastic and ultimate load method.	1
2.2	Analysis of member in flexure.	1
2.3	Analysis of member in flexure and related problem - Ultimate strength in Flexure using IS 1343-2012.	1
2.4	Analysis of member in flexure and related problem - Ultimate strength in Flexure using IS 1343-2012.	1
2.5	Design of sections for flexure codal provisions.	1
2.6	Design of sections for flexure codal provisions - Problems.	1
2.7	Design of sections for flexure codal provisions - Problems.	1
MODULE III (7 Hours)		
3.1	Analysis of prestressed members in shear.	1
3.2	Analysis and Design of prestressed members in shear - Problems.	1
3.3	Analysis and Design of prestressed members in shear - Problems.	1
3.4	Analysis of prestressed members in Torsion.	1
3.5	Analysis of prestressed members in Torsion.	1
3.6	Analysis and Design of prestressed members in Torsion - Problems.	1
3.7	Analysis and Design of prestressed members in Torsion - Problems.	1
MODULE IV (7 Hours)		
4.1	Deflections of prestressed concrete members.	1
4.2	Calculation of Short Term Deflection using Codal Provisions.	1
4.3	Calculation of Long Term Deflection using Codal Provisions.	1
4.4	Anchorage zone stresses in post tensioned members.	1
4.5	Anchorage zone stresses in post tensioned members.	1
4.6	Design of end block.	1

4.7	Design of end block.	1
MODULE V (7 Hours)		
5.1	Introduction to Composite construction.	1
5.2	Composite construction - Concepts.	1
5.3	Stresses due to differential shrinkage - ultimate moment of resistance.	1
5.4	Analysis of continuous beams.	1
5.5	Analysis of continuous beams.	1
5.6	Statically Indeterminate structures: advantages of continuous member.	1
5.7	Statically Indeterminate structures: advantages of continuous member.	1

CO Assessment Questions	
CO1	1. A post-tensioned beam AB of span 25 m is prestressed with an initial prestressing force of 400 kN at the jacking end A of the beam. The cable is having zero eccentricity at the supports A and B and an eccentricity of 400 mm towards the soffit at mid-span. The coefficient of friction μ = 0.30 and the coefficient of wave effect K = 0.0043/m. Determine: i) The loss of prestressing force in the cable due to friction. ii) The effective prestressing force in the cable at the farther end B of the beam. 2. A rectangular concrete beam, 100 mm wide by 250 mm deep spanning over 8 m is prestressed by a straight cable carrying an effective prestressing force of 250 kN located at an eccentricity of 40 mm. The beam supports a live load of 1.2 kN/m. Calculate the resultant stress distributing for the central cross section of the beam. The density of concrete is 24kN/m^3.
CO2	1. Design a prestressed concrete I-beam to carry a superimposed load of 12 kN/m over a span of 20 m. The thickness of the flange and web may be taken as 150mm. Loss of prestressing force = 20 %. Allowable compressive strength in concrete = 12 N/mm^2. No tension is allowed in concrete. 2. Estimate the ultimate flexural strength at the mid-span section of an I-section bridge girder using IS 1343 Codal provisions. The overall depth of the girder is 1500 mm; The width and thickness of the top flange is 900 mm and 250 mm respectively; The size of the bottom flange is 600 mm x 300 mm; Thickness of the web is 250 mm. The girder is used over a span of 25 m and post-tensioned with effective bond using tendons having an

	area of 6000 mm^2. The tendons are parabolic with an eccentricity of 750 mm at the centre of span and zero at the supports. Take f_{cu} = 45 N/mm^2 and f_{pu} = 1700 N/mm^2.
CO3	1. A prestressed girder of rectangular section 150mm wide by 350mm deep is to be designed to support an ultimate shear force of 160kN. The uniform prestress across the section is 7 N/mm^2.fck= 40 N/mm^2 and fe415 grade steel of 8mm diameter, design suitable spacing for the stirrups confirming to the IS 1343. Assume cover as 60mm. 2. A prestressed concrete beam of rectangular cross-section is subjected to an effective prestressing force of 500 kN provided by 5 numbers of 12.5 mm diameter strands of cross-sectional area 506 mm2. The cross-sectional dimension of the beam is 450 mm × 600 mm. The eccentricity of the posttensioned tendon is 150 mm. A service load Bending Moment of 176 kNm, Torsional Moment of 56 kNm and Shear Force of 75kN are acting at the section of the beam. Take the cube strength of concrete as 40N/mm2 and the ultimate tensile strength of tendons as 1820 N/mm2. Using IS 1343 codal provisions design the longitudinal reinforcement of the beam.
CO4	1. The end block of a pre stressed concrete beam, rectangular in section, is 150mm wide and300mm deep. The pre stressing force of 250kN is transmitted to concrete by a distribution plate, 150 mm wide and 50mm deep concentrically located at the ends. Calculate the position and magnitude of the maximum tensile stress on the horizontal section through the centre of the anchor plate. 2. Two cables each carrying a prestressing force of 2800 kN are anchored using a square anchor plate of side 305 mm at the end block of a post-tensioned beam of 500 mm wide and 1000 mm deep. The centres of the anchor plate are 250 mm from the top and bottom edges of the beam. Design suitable reinforcements in the end block using IS code provisions. Use Fe-415 grade steel bars.
CO5	1. A precast pre tensioned beam of rectangular section has a breadth of100mm and a depth of 200mm. The beam with an effective span of 5m, is pre stressed by tendons. The centroid of the section lies at 87mm from the top fibre. The initial force in the tendons is 150kN. The loss of pre stress may be assumed as 15%. The beam is incorporated in a composite T-beam by casting a top flange of breadth 400mm and a thickness 40mm. If the composite beam supports a live load of 8kN/m^2, calculate the resultant stresses developed in the precast and cast in situ concrete assuming the pre tensioned beam as unpropped. Assume same modulus of elasticity.

	2. A simply supported composite T-section beam is having a span of 4.5 m. The beam is made composite by casting an in-situ concrete slab of size 300 mm x 50 mm on the top of a rectangular pre-tensioned concrete beam of size 100 mm x 230 mm. The prestress occurred after all losses in the rectangular pretensioned beam are 12 N/mm^2 at the soffit and zero at the top. Calculate the maximum uniformly distributed live load on the composite beam, without occurring any tensile stresses, if the slab is i) propped, and ii) un-propped while casting.

24CEE624	ADVANCED CONCRETE TECHNOLOGY	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of the course is to enable the students to familiarise with the advanced concepts of concrete technologies used in construction. This course is aimed at exposing the students to the fundamentals of properties of concrete materials, its testing procedures, various types of concretes, NDT of concrete and mix design. After this course, students will be in a position to determine the properties of concrete materials, testing of concrete and do a mix design based on requirement.

Prerequisite: 24EST302 Material Science and Engineering

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

CO 1	Recall the properties, effects and uses of concrete ingredients. (Remember level)
CO 2	Design concrete mix using IS Code Method. (Understand and Apply level)
CO 3	Describe the procedure of determining the properties of fresh and hardened concrete. (Understand level)
CO 4	Explain non-destructive testing of concrete. (Understand level)
CO 5	Explain the various special types of concretes and special processes. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	2	2	-	-	-	-	-
CO 2	3	-	3	-	-	2	-	-	-	-	-	-
CO 3	3	-	-	-	-	2	-	-	-	-	-	-
CO 4	3	-	-	-	-	2	-	-	-	-	-	-
CO 5	3	-	-	-	-	-	1	-	-	-	-	1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓			✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Note:- One Assignment per module shall be given and best of FOUR shall be considered for the calculation of CIA.

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern:

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Concrete Materials)

Cement - Review of manufacturing process - chemical composition, Bogue's compounds, mechanism of hydration – structure of hydrated cement - heat of hydration.

Aggregate - Review of types, sampling and testing, artificial aggregates.

Chemical Admixtures - types, uses, mechanism of action - effects on properties of concrete.

Mineral admixtures - types, chemical composition – physical characteristics - effects on properties of concrete, pozzolanic reaction, advantages and disadvantages.

Fibres – Types, influence on the properties of concrete, applications.

MODULE II (Mix Proportioning)

Mix design - nominal mix - design mix – concept of mix design - variables of proportioning - general considerations - factors considered in the design of concrete

mix - various methods of mix design - design of concrete mix as per IS 10262-2019. (design of concrete with and without chemical/mineral admixtures)

Statistical quality control of concrete – concept of characteristic strength - mean strength – standard deviation – coefficient of variation – sampling - testing - acceptance criteria.

MODULE III (Properties of Fresh and Hardened Concrete)

Properties of fresh concrete – workability - factors affecting workability - slump test - compaction factor test - Vee Bee test.

Advanced topics in fresh concrete - Rheology – basic concepts – Bingham model, pumping of concrete.

Properties of hardened concrete - modulus of elasticity, compressive strength, split tensile strength, flexural strength - effect of water cement ratio – maturity concept.

Creep - factors affecting creep - effect of creep.

Shrinkage - factors affecting shrinkage - plastic shrinkage, drying shrinkage, autogenous shrinkage, carbonation shrinkage.

MODULE IV (Durability and Non-destructive Testing of Concrete)

Durability of concrete - Factors affecting durability – permeability – cracking – reinforcement corrosion; carbonation, chloride penetration, sulphate attack, acid attack, fire resistance, frost damage, alkali silica reaction, concrete in sea water.

Non-destructive testing of concrete – surface hardness test - ultrasonic pulse velocity method - penetration resistance - pull-out test – core cutting and testing – detection of reinforcement and measuring reinforcement cover.

MODULE V (Special Topics in Concrete Technology)

Special concretes - lightweight concrete - heavy weight concrete - high strength concrete – high performance concrete - self compacting concrete - roller compacted concrete – fibre reinforced concrete - polymer concrete - pumpable concrete - ready mixed concrete – alkali activated concrete - recycled aggregate concrete – pervious concrete.

Special processes and technology - sprayed concrete, underwater concrete, mass concrete, slip form construction, vacuum dewatered concrete, prefabrication technology - 3D concrete printing.

Text books

1) Neville A.M., "Properties of Concrete", Trans-Atlantic Publications, Inc.; 5e, 2016.
2) R. Santhakumar, "Concrete Technology", Oxford Universities Press, 2018.
3) Shetty M. S., "Concrete Technology", S. Chand & Co., 2018.

Reference books

1) Gambhir M. L. (2004), Concrete Technology, Tata McGraw-Hill Publishing Company Limited.
2) Mehta and Monteiro, Concrete-Micro structure, Properties and Materials", McGraw Hill Professional, 2017.
3) Neville A. M. and Brooks J. J., Concrete Technology, Pearson Education, 2019.

4) Lea, Chemistry of Cement and Concrete, Butterworth-Heinemann Ltd, 5e, 2017.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Hours (36)
	MODULE I (7 Hours)	
1.1	Cement - Review of manufacturing process.	1
1.2	chemical composition, Bogue's compounds, mechanism of hydration, structure of hydrated cement, heat of hydration.	1
1.3	Aggregate - Review of types, sampling and testing, artificial aggregates.	1
1.4	Chemical Admixtures - types, uses, mechanism of action - effects on properties of concrete.	1
1.5	Mineral admixtures - types, chemical composition – physical characteristics - effects on properties of concrete.	1
1.6	Pozzolanic reaction, advantages and disadvantages.	1
1.7	Fibres – Types, influence on the properties of concrete, applications.	1
	MODULE II (7 Hours)	
2.1	Mix design - nominal mix - design mix – concept of mix design - variables of proportioning - general considerations.	1
2.2	Factors considered in the design of concrete mix.	1
2.3	Various methods of mix design - design of concrete mix as per IS 10262-2019.	1
2.4	Design of concrete mix as per IS 10262-2019. (design of concrete with and without chemical/mineral admixtures)	1
2.5	Design of concrete mix as per IS 10262-2019. (design of concrete with and without chemical/mineral admixtures)	1
2.6	Statistical quality control of concrete – concept of characteristic strength - mean strength – standard deviation – coefficient of variation.	1
2.7	Sampling - testing - acceptance criteria.	1
	MODULE III (7 Hours)	
3.1	Properties of fresh concrete – workability - factors affecting workability.	1
3.2	slump test - compaction factor test - Vee Bee test.	1
3.3	Advanced topics in fresh concrete - Rheology – basic concepts – Bingham model, pumping of concrete.	1

3.4	Properties of hardened concrete - modulus of elasticity, compressive strength, split tensile strength, flexural strength.	1
3.5	Effect of water cement ratio – maturity concept.	1
3.6	Creep - factors affecting creep - effect of creep.	1
3.7	Shrinkage - factors affecting shrinkage - plastic shrinkage, drying shrinkage, autogenous shrinkage, carbonation shrinkage.	1
MODULE IV (7 Hours)		
4.1	Durability of concrete - Factors affecting durability – permeability.	1
4.2	Cracking – reinforcement corrosion.	1
4.3	Carbonation, chloride penetration, sulphate attack.	1
4.4	Acid attack, fire resistance, alkali silica reaction, concrete in sea water.	1
4.5	Non-destructive testing of concrete – surface hardness test - ultrasonic pulse velocity method.	1
4.6	Penetration resistance- pull-out test.	1
4.7	Core cutting and testing, detection of reinforcement and measuring reinforcement cover.	1
MODULE V (8 Hours)		
5.1	Special concretes - lightweight concrete - heavy weight concrete.	1
5.2	High strength concrete – high performance concrete.	1
5.3	Self compacting concrete - roller compacted concrete.	1
5.4	Fibre reinforced concrete - polymer concrete - Pumpable concrete.	1
5.5	Ready mixed concrete – alkali activated concrete – recycled aggregate concrete – pervious concrete.	1
5.6	Special processes and technology - sprayed concrete, underwater concrete, mass concrete, slip form construction.	1
5.7	Vacuum dewatered concrete, prefabrication technology.	1
5.8	3D concrete printing.	1

CO Assessment Questions	
CO1	Explain the advantages and disadvantages of using mineral admixtures in concrete.
CO2	Design a concrete mix for a grade of M25 without chemical admixtures. Assume the following data: specific gravity of cement, fine aggregate, 10 mm aggregate and 20 mm aggregate as 3.15, 2.62, 2.72, 2.75 respectively. Fine aggregate belongs to Zone II. Assume any other missing data suitably.
CO3	Define shrinkage in concrete. Enumerate and explain the various types of shrinkage in concrete.
CO4	Explain the procedure of ultrasonic pulse velocity testing to determine the quality of concrete. State its merits and demerits.
CO5	Explain various types of light weight concrete highlighting its composition, properties and applications.

24CEE634	GEOTECHNICAL SITE INVESTIGATION	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to equip students with the knowledge of site investigation and the methods to be undertaken for the smooth conduct of surface and subsurface exploration. This course covers site investigation procedure, direct and indirect methods of surface and subsurface exploration, field tests, and preparation of soil investigation report. This course will enhance the capability of students to make sound engineering judgements related to field based on detailed analysis and recommend the appropriate methods for the smooth conduct of site investigation.

Prerequisite: 24CET402 Soil Mechanics

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

CO1	Describe the procedure, applicability, and limitations of various methods of geotechnical investigation. (Understand Level)
CO2	Apply engineering judgments and make appropriate decisions related to geotechnical investigations. (Understand and Apply Level)
CO3	Discuss the procedure and applications of penetration tests and geophysical tests for exploration of the soil profile. (Understand Level)
CO4	Choose the right soil sampling technique and analyze the dependability of samples collected. (Analyze Level)
CO5	Describe the procedure and applications of field load tests and rock quality indices. (Understand Level)

CO – PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember				
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyze				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hrs

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN I	10 Questions, each question, 2 questions from each module, each carries 3 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (8×5 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (SITE INVESTIGATION PROGRAMME)

Introduction and practical importance – Objectives of soil exploration – Planning of a sub-surface exploration program – Introduction to index and engineering properties of soils – Collection of existing information, reconnaissance, preliminary and detailed investigation

– I.S. and other guidelines for deciding the number, size, spacing, and depth of boreholes. Methods of exploration – Open pits – Auger boring –Wash boring, percussion drilling, rotary drilling.

MODULE II (SOUNDING METHODS)

Sounding methods: Standard Penetration Test – Procedure – corrections to be applied to observed N values – Numerical examples – Factors influencing the SPT results and precautions to obtain reliable results – Merits/drawbacks of the test – Correlations of N value with various engineering and index properties of soils.
Static Cone Penetration Test – Procedure – Merits/drawbacks –Correlation of static CPT results with soil properties – Dynamic Cone Penetration Test – Brief Procedure – Merits/drawbacks –Critical comparison of SPT, static CPT, and dynamic CPT.

MODULE III (GEOPHYSICAL METHODS)

Geophysical methods – Seismic refraction method – Procedure, uses, limitations – Solution of numerical problems to estimate the velocity of seismic waves and the thickness of the upper layer of a two-layered soil system – Electrical resistivity method – Electrical profiling and electrical sounding – Procedure, uses, limitations. Stabilization of boreholes, Groundwater level estimation.

MODULE IV (SAMPLING AND SAMPLERS)

Soil sampling – Undisturbed, disturbed, and representative samples – Chunk and tube samples – Factors affecting sample disturbance and methods to minimize them – Area ratio – Inside clearance – Outside clearance – Recovery ratio – Ball check valve – Numerical Problems –Handling and transportation of samples – Extrusion of samples.
Types of samplers – Thin-walled sampler – Piston sampler – Split spoon sampler – Methods for collection of sand samples from beneath the water table – Core retainers.

MODULE V (FIELD TESTS AND SOIL REPORT)

Pressure meter test – Procedure – Uses – limitations, Flat Dilatometer Test (Brief only) - Plate load test – Procedure, uses, and limitations – modulus of subgrade reaction – Solution of numerical problems using plate load test data Rock core sampling, Rock Quality Designation, Core Recovery Ratio – Numerical on core recovery and rock quality – Bore log – Soil profile – Sub-soil investigation report.

Text books

1. Gopal Ranjan and A.S.R. Rao, “Basic and Applied Soil Mechanics”, New Age International (P) Limited, New Delhi, 2002.
2. Venkata Ramaiah, “Geotechnical Engineering”, Universities Press (India) Limited, Hyderabad, 2000.

Reference books

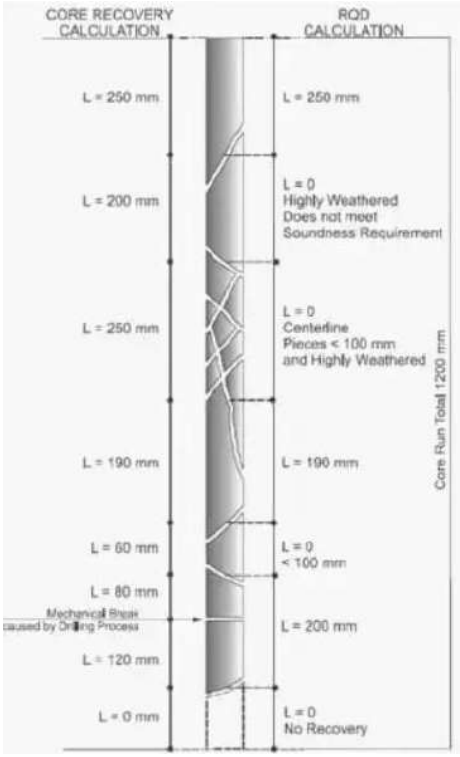
1. Arora K.R., “Geotechnical Engineering”, Standard Publishers Distributors, New Delhi, 2006.

2. Joseph E. Bowles, „Foundation Analysis and Design", Mc. Graw Hill Inc., New York, 1988.
3. Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Kindersley (India) Pvt. Ltd., 2013.
4. Terzaghi K. and R.B. Peck, Soil Mechanics in Engineering Practice, John Wiley, 1967.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
MODULE 1 (8 Hours)		
1.1	Introduction and practical importance – Objectives of soil exploration.	1
1.2	Introduction to index and engineering properties of soils.	1
1.3	Planning of a sub-surface exploration program – Collection of existing information.	1
1.4	Reconnaissance, preliminary and detailed investigation.	1
1.5	I.S. and other guidelines for deciding the number, size, spacing, and depth of boreholes.	1
1.6	Methods of exploration - Open pits – Auger boring.	1
1.7	Wash boring, percussion drilling, rotary drilling.	1
1.8	Wash boring, percussion drilling, rotary drilling.	1
MODULE 2 (7 Hours)		
2.1	Sounding methods Standard Penetration Test – Procedure.	1
2.2	Corrections to be applied to observed N values – Numerical examples.	1
2.3	Factors influencing the SPT results and precautions to obtain reliable results – Merits/drawbacks of the test.	1
2.4	Correlations of N value with various engineering and index properties of soils.	1
2.5	Static Cone Penetration Test – Procedure Merits/drawbacks.	1
2.6	Correlation of static CPT results with soil properties.	1
2.7	-Dynamic Cone Penetration Test – Brief Procedure – Merits/drawbacks – Critical comparison of SPT, static CPT, and dynamic CPT.	1
MODULE 3 (7 Hours)		
3.1	Geophysical methods – Seismic refraction method – Procedure.	1

3.2	Uses, limitations of Seismic refraction method.	1
3.3	Solution of numerical problems to estimate the velocity of seismic waves and the thickness of the upper layer of a two-layered soil system.	1
3.4	Solution of numerical problems to estimate the velocity of seismic waves and the thickness of the upper layer of a two-layered soil system.	1
3.5	Electrical resistivity method – Electrical profiling and electrical sounding – Procedure.	1
3.6	Uses, limitations of Electrical resistivity methods.	1
3.7	Stabilization of boreholes, Groundwater level estimation.	1
MODULE 4 (7 Hours)		
4.1	Soil sampling – Undisturbed, disturbed, and representative samples.	1
4.2	Chunk and tube samples – Factors affecting sample disturbance and methods to minimize them.	1
4.3	Area ratio - Inside clearance – Outside clearance - Recovery ratio –Ball check valve.	1
4.4	Numerical Problems.	1
4.5	Handling and transportation of samples – Extrusion of samples.	1
4.6	Types of samplers – Thin-walled sampler – Piston sampler – Split spoon sampler.	1
4.7	Methods for collection of sand samples from beneath the water table - Core retainers.	1
MODULE 5 (7 Hours)		
5.1	Pressure meter test - Procedure – Uses – limitations.	1
5.2	Flat Dilatometer Test (Brief only).	1
5.3	Plate load test – Procedure, uses, and limitations.	1
5.4	Modulus of subgrade reaction- Solution of numerical problems using plate load test data.	1
5.5	Rock core sampling, Rock Quality Designation, Core Recovery Ratio.	1
5.6	Numerical on core recovery and rock quality.	1
5.7	Bore log – Soil profile – Sub-soil investigation report.	1

CO Assessment Questions	
CO1	1. Explain the method of drilling employed for rocks with a figure and list the limitations. 2. Mention the limitations of wash boring method.
CO2	1. Determine the rock quality index and core recovery for the rock sample recovered from site.  2. One sampler has an area ratio of 8% while another has 16%; which of these samplers do you prefer and why?
CO3	1. List the precautions to be taken while conducting a Standard Penetration Test. 2. Mention the advantages of the static cone penetration test over the Standard Penetration Test.
CO4	1. Compute the area ratio of thin-walled tube samples having an external diameter of 6 cm and a wall thickness of 2.25 mm. Do you recommend the sampler for obtaining undisturbed soil samples? Why? 2. Mention the sampler type used for collecting underwater sand samples. Also, describe the technique adopted.
CO5	1. With a neat sketch, explain the procedure and applications of the Pressuremeter test. 2. How is the quality of rock samples assessed?

24CEE644	MECHANICS OF FLUID FLOW	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to familiarize students with the fundamental principles governing the behavior of fluids in motion and at rest, emphasizing their application in various engineering scenarios. The goal is to enable students to comprehend and apply theoretical concepts such as fluid dynamics, viscosity, and fluid statics in practical engineering problems involving fluid flow. The anticipated outcomes include the ability of students to analyze and solve complex fluid flow problems, design efficient fluid systems, and apply acquired knowledge to real-world engineering challenges in fields like aerospace, mechanical engineering, and civil engineering.

Prerequisite: 24CEP403 Fluid Mechanics

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

CO 1	Describe and apply the principles of potential flow and viscous flow. (Apply level)
CO 2	Analyze the boundary layer flow. (Apply level)
CO 3	Perform the computations of turbulent flows through pipes by recollecting the relevant hydraulic principles. (Apply level)
CO 4	Analyze the unsteady flow through pipes, channels and tanks. (Apply level)
CO 5	Prepare physical models for performing experiments recalling the principles of fluid flow. (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Potential flow and Viscous flow)

Fluid flow: Types of fluid flow (Review) - Potential flow - velocity potential, stream function, streamlines and equipotential lines, flow net - uses and limitations
Viscous flow – Reynold's experiment; Shear stress - pressure gradient relationship - Laminar flow through pipes (Hagen-Poiseulle Equation), laminar flow between stationary parallel plates.

MODULE II (Boundary layer flow)

Boundary layer flow - no slip condition; boundary layer thickness, boundary layer growth over long thin plate - laminar and turbulent boundary layer, laminar sub layer; Momentum integral equation of boundary layer (no derivation), Blasius boundary layer equations for laminar and turbulent boundary layer, computation of drag on a flat plate. Separation of boundary layer and control.

MODULE III (Turbulent flow)

Turbulent flow - Computation, velocity distribution, Head loss due to friction in pipes - Nikuradse experiment with artificially roughened pipe, Friction coefficient for laminar and turbulent flows, Moody's diagram, reduction of carrying capacity of pipes with age. Hazen William's formula.

MODULE IV (Unsteady flow through pipes and tanks)
Unsteady flow through pipes - Transients in pipes - water hammer effects; Flow under variable heads, time of emptying tanks, time of emptying through weirs.
MODULE V (Experimental fluid flow)
Experimental Fluid Mechanics - Physical modeling-Dimensional analysis - Reyleigh's method, Buckingham's pi-theorem, Similitude, Reynolds Number and Froude Number, Model laws for viscous and channel flows; Scale effect, distorted and undistorted models.
Text books 1. Kumar D.N. Fluid Mechanics and Fluid power Engineering, S.K. Kataria & sons, 2013. 2. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002.
Reference books 1. Arora K.R. Fluid Mechanics, Hydraulics and Hydraulic Machines, Standard Publishers, 2005. 2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2005. 3. Bruce R Munson, Donald F Young. Fundamentals of Fluid Mechanics, John Wiley & sons, 2011. 4. Frank M. White, Fluid Mechanics, Mc Graw Hill, 2013. 5. Jain A. K., Fluid Mechanics, Khanna Publishers, Delhi, 1996. 6. Streeter V.L. Fluid Mechanics, Mc Graw Hill Publishers. 7. Subramanya K., Theory and Applications of Fluid Mechanics, Tata McGraw-Hill, 1993.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (8 hours)	
1.1	Fluid flow: Types of fluid flow. (Review)	1
1.2	Potential flow-velocity potential, stream function-practical applications of flow net and limitations.	1
1.3	Numerical computations on velocity potential and stream function.	1
1.4	Viscous flow – Reynold's experiment.	1
1.5	Shear stress- pressure gradient relationship – Laminar flow through pipes. (Hagen-Poiseulle Equation)	1
1.6	Hagen-Poiseulle Equation - Numerical Applications.	1

1.7	laminar flow between stationary parallel plates.	1
1.8	Problem solving on viscous flow.	1
MODULE II (7 hours)		
2.1	Boundary layer flow-no slip condition.	1
2.2	boundary layer thickness, computations.	1
2.3	boundary layer growth over long thin plate - laminar and turbulent boundary layer, laminar sub layer.	1
2.4	Momentum integral equation of boundary layer (no derivation), Blasius boundary layer equations for laminar and turbulent boundary layer.	1
2.5	Numerical examples on boundary layer development over flat plate.	1
2.6	Computation of drag on a flat plate.	1
2.7	Separation of boundary layer and control.	1
MODULE III (7 hours)		
3.1	Turbulent flow - Computation, velocity distribution.	1
3.2	Numerical applications on velocity distribution in pipes.	1
3.3	Head loss due to friction in pipes - Nikuradse experiment with artificially roughened pipe, Friction coefficient for laminar and turbulent flows.	1
3.4	Numerical examples on turbulent flow through roughened pipes.	1
3.5	Moody's diagram and applications.	1
3.6	Reduction of carrying capacity of pipes with age, Hazen William's formula, Numerical examples.	1
3.7	Problem solving on turbulent flow.	1
MODULE IV (7 hours)		
4.1	Concept of Unsteady flow and applications.	1
4.2	Unsteady flow through pipes – Transients in pipes - water hammer effects.	1
4.3	Numerical computations on water hammer in pipes	1

4.4	Review on Orifices, Flow under variable heads - time of emptying tanks.	1
4.5	Practical applications on time of emptying of tanks.	1
4.6	Time of emptying through weirs - computations.	1
4.7	Numerical examples on transients.	1
MODULE V (7 hours)		
5.1	Experimental Fluid Mechanics- Physical modelling, Similitude	1
5.2	Dimensional analysis- Reyleigh's method and numerical applications	1
5.3	Buckingham's pi- theorem and numerical applications	1
5.4	Reynolds Number and Froude Number, Model laws for viscous and channel flows;	1
5.5	Numerical applications of Model laws for viscous and channel flows	1
5.6	Scale effect, distorted and undistorted models	1
5.7	Numerical examples on physical modeling, Experimental Fluid Mechanics- Physical modelling, Similitude	1

CO Assessment Questions	
CO1	1. State the applications of flow net. 2. Describe Reynold's experiment. 3. Show that stream lines and equi- potential lines intersect orthogonally. 4. Crude oil of dynamic viscosity 1.5 Poise and relative density 0.9 flows through a 20 mm vertical pipe. The pressure gauges fitted at an upper point A measure 58.86 N/cm2 while that fitted at another point B, 20 m below A reads 19.62 N/cm2. Is the flow laminar? Find the direction of flow and rate of flow. 5. The velocity components in a two-dimensional incompressible flow are and. (i) Is the flow irrotational? (ii) Evaluate the potential function and stream function.
CO2	1. Explain boundary layer separation. 2. State the characteristics of boundary layer growth over flat plate. 3. A smooth fat plate 2 m wide and 2.5 m long is towed in oil (Relative density of 0.8) at a velocity of 1.5 m/s along its length. Find the thickness of boundary layer and shear stress at the trailing edge of the plate.

	4. A flat plate 1.5 m and length L is kept parallel to the uniform stream of air velocity 3 m/sec in a wind tunnel. If the boundary layer developed is of laminar in character, what is the maximum length of the plate? Also find the drag force on one side of the plate Air density is 1.2 kg/m3 and its dynamic viscosity is 1.45 x10-5 m^2/s.
CO3	1. Explain the use and characteristics of Moody's diagram. 2. Describe the characteristics of velocity distribution in turbulent regime. 3. A 300 mm diameter water supply pipe had a friction factor of 0.02 when freshly laid. After 10 years of service, the friction factor was found to be 0.025. what friction factor can be expected after another 15 years? The pipe is assumed to be in rough turbulent flow regime. 4. Explain the role of surface aging in carrying capacity of commercial pipes. 5. A pipeline 30 cm diameter carries 300 l/s of petrol (density=600 kg/m3; dynamic viscosity=2.9 x 10-4 Pas). Calculate (i) the friction factor (ii) shear stress at the boundary (iii) shear stress and velocity at 5 cm from the pipe axis (iv) maximum velocity and thickness of laminar sublayer Assume the pipe to be hydrodynamically rough.
CO4	1. A steel pipe 20 cm in diameter and 1000 m long conveys a discharge of 40 l/sec of crude oil. A valve at downstream end of the pipe is completely closed in 1.25 s. If the pipe thickness is 10 mm, calculate the additional stress in the pipe due to valve operation. 2. A circular tank of diameter 3 m contains water upto a height of 4 m. The tank is provided with an orifice of diameter 0.4 m at the bottom. Find the time taken by water (i) to fall from 4 m to 2 m (ii) for completely emptying the tank Take Cd=0.6.
CO5	1. Describe Rayleigh's method of dimensional analysis. 2. Describe scale effect in physical model studies. 3. A 1:20 spillway model has a discharge of 2.25 m3/s. what is the corresponding prototype discharge? If a flood phenomenon takes 10 h to occur in the prototype, how long will it in the model? 4. The discharge Q over a small rectangular weir is known to depend upon head H over the weir, the height of the weir P, acceleration due to gravity g, width of the weir L and fluid properties ρ, dynamic viscosity μ an surface tension σ. Express the relationship between the variables in dimensionless form using Buckingham – π theorem.

24CEE654	OPEN CHANNEL HYDRAULICS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to provide students with an in-depth understanding of the principles governing the behavior of fluids in open channels, focusing on their flow, properties, and interactions with different channel geometries. The goal is to equip students with the necessary theoretical knowledge and practical skills to analyze and design open channel systems, including channels, rivers, and culverts, emphasizing the application of hydraulic principles in civil and environmental engineering projects. The anticipated outcomes include the ability of students to perform hydraulic calculations, assess flow characteristics, design and manage open channel systems, and address real-world hydraulic challenges in water resource management and infrastructure development.

Prerequisite: 24CEP403 Fluid Mechanics

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

CO 1	Apply the principles of uniform flow computation in open channels. (Apply level)
CO 2	Analyze the flow through open channels using specific energy concepts for practical applications. (Apply and Analyse level)
CO 3	Analyse the flow through open channels for gradually varied flow cases. (Apply and Analyse level)
CO 4	Apply the principles of rapidly varied flow through open channels and describe its practical applications. (Understand and Apply level)
CO 5	Apply the principles of rapidly varying unsteady flow and spatially varied flow through open channels. (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse	✓	✓		✓
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Uniform flow)

Open channel flow, Most economical sections – rectangular and trapezoidal channels, condition for maximum discharge and maximum velocity through circular channels; Computation of discharge through compound channels; Velocity distribution in open channels, Pressure distribution in curvilinear flows - flows through spillway crest and spillway bucket.

MODULE II (Specific energy and applications)

Specific energy - specific energy diagram and discharge diagram, Critical flow and its computation. Application of Specific energy for channel transitions - hump and reduction in channel width; Conveyance and section factor for uniform and critical flow. Hydraulic exponents for uniform and critical flow.

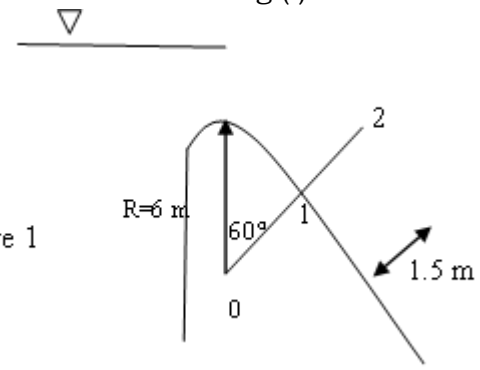
MODULE III (Gradually varied flow)
Gradually varied flow - Dynamic equation of gradually varied flow - different forms; types and characteristics of water surface profiles in rectangular prismatic channels Computation of length of water surface profiles - direct step method, Bresse's method Standard step method.
MODULE IV (Rapidly varied flow)
Specific force; Rapidly varied flow - Hydraulic jump - conjugate or sequent depths, expression for sequent depths and energy loss for a hydraulic jump in horizontal rectangular channels, types, uses and characteristics of hydraulic jump. Hydraulic jumps in sloping and exponential channels, Hydraulic jumps – types based on tail water conditions. Uses of hydraulic jumps for energy dissipation below spillways - jump height curve; tail water rating curve; Design features of stilling basins, Standing wave flume, Parshall flume.
MODULE V (Spatially varied flow and Unsteady flow)
Unsteady flow through open channels – Surges - positive surges (problems) and concept of negative surges; Spatially varied flow, dynamic equation of spatially varied flow, Analysis of spatially varied flow profile.
Text books 1. Subramanya K., Theory and Applications of Fluid Mechanics, Tata McGraw-Hill, 1993. 2. Subramanya K., Flow in Open channels, Tata McGraw-Hill, 2009.
Reference books 1. Chow V.T., Flow through Open Channels, McGraw Hill, 1959. 2. Rangaraju K.G., Flow through Open Channels, Tata McGraw Hill, 1994. Srivastava R., Flow through Open Channels, Oxford Publishers, 2012

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (7 hours)	
1.1	Open channel flow – Uniform flow computations-numerical examples.	1
1.2	Most economical rectangular and trapezoidal channels - conditions.	1
1.3	Most economical sections – numerical examples.	1
1.4	Condition for maximum discharge and maximum velocity through circular channels.	1
1.5	Computation of discharge through compound channels.	1
1.6	Velocity distribution and pressure distribution; Pressure distribution in curvilinear flows.	1

1.7	Pressure distribution-numerical examples.	1
MODULE II (8 hours)		
2.1	Specific energy- specific energy diagram and discharge diagram.	1
2.2	Critical flow and its computation.	1
2.3	Numerical examples on critical flow.	1
2.4	Application of Specific energy for channel transitions.	1
2.5	Channel transitions - hump and reduction in channel width.	1
2.6	Analysis of flow through channel transitions.	1
2.7	Conveyance and section factor for uniform and critical flow.	1
2.8	Hydraulic exponents of uniform and critical flow.	1
MODULE III (6 hours)		
3.1	Gradually varied flow - Dynamic equation of gradually varied flow - different forms.	1
3.2	Types and characteristics of water surface profiles in rectangular prismatic channels.	1
3.3	Classification of water surface profiles - numerical examples.	1
3.4	Computation of length of water surface profiles - direct step method - examples.	1
3.5	Bresse's method and standard step method.	1
3.6	Numerical examples on gradually varied flow computations.	1
MODULE IV (8 hours)		
4.1	Expression for sequent depths and energy loss for a hydraulic jump in horizontal rectangular channels.	1
4.2	Numerical computations on hydraulic jump in horizontal rectangular channels.	1
4.3	Hydraulic jumps in exponential channels and sloping channels.	1
4.4	Types, types based on tail water conditions uses and characteristics of hydraulic jump.	1
4.5	Location of hydraulic jumps - examples.	1

4.6	Stilling basins, Use of Parshall flume and standing wave flumes for discharge measurements.	1
4.7	Uses of hydraulic jumps for energy dissipation below spillways - jump height curve; tail water curve; Stilling basins.	1
4.8	Expression for sequent depths and energy loss for a hydraulic jump in horizontal rectangular channels.	1
MODULE V (7 hours)		
5.1	Unsteady flow through open channels – Surges.	1
5.2	Positive surges. (Numerical problems)	1
5.3	Practical cases of Positive surges.	1
5.4	Concept and computation of negative surges.	1
5.5	Spatially varied flow – dynamic equation.	1
5.6	Analysis of spatially varied flow profiles.	1
5.7	Numerical examples on Spatially varied flow computations.	1

CO Assessment Questions	
CO1	1. Determine the most efficient section of a trapezoidal channel with side slope 1 vertical to 2 Horizontal carrying a discharge of 11.25 m3/sec with a velocity of 0.75m/sec. What should be the bed slope of the channel? Assume Manning's n=0.025. 2. For the flow over a spillway with circular arc shown in Figure 1, obtain the value of pressure at point 1for discharge q=5 m3/s/m for a constant flow depth of 1.5 m assuming (i) forced vortex flow and (ii) free vortex flow  Figure 1
CO2	1. In a rectangular channel, the specific energy is 2m and one of the alternate depth is 0.5m. Calculate the other alternate depth, critical depth and discharge intensity.

	2. A discharge of 15 cumecs flows through a rectangular channel 3 m wide. The depth of flow is 2 m. What is the minimum width beyond which the flow depth at upstream gets disturbed? A smooth hump of 0.1 m is built in the channel and at this section the width is 2.8 m. Analyze the water depth at contracted section and the upstream section. 3. Explain Hydraulic exponents and its use in open channel computations.
CO3	1. Enlist the assumptions in the derivation of dynamic equation of gradually varied flow. 2. A rectangular flume 2m wide carries discharge at a rate of 2m3/s. The bed slope of the flume is 0.0004. At a certain section the depth of flow is 1m.Calculate the distance to a section downstream where the depth of flow is 0.9m.Solve by direct step method employing single step. Assume Manning's 'n' as 0.014.
CO4	1. A horizontal rectangular channel 4m wide carries 16m^3/s of discharge. Determine the depth sequent to an initial depth of 0.5m and energy loss in the jump. 2. Describe the features of Parshall flume and standing wave flume for discharge measurement.
CO5	1. A rectangular channel had a positive surge of velocity 8 m/s moving down the channel. If the depth and velocity after the passage of surge are 3.5m and 4.5m/s, estimate the depth and velocity before the passage of the surge. 2. Derive the dynamic equation of spatially varied flow.

24CEE664	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course on Environmental Impact Assessment equips students with the knowledge and skills to assess the consequences of human activities on the environment. In this, the students will explore the fundamental principles and methodologies essential for evaluating and mitigating the environmental consequences of development projects. After the completion of the course, the students will be able to have a comprehensive understanding of sustainable practices, regulatory frameworks, and the role of EIA in fostering responsible environmental stewardship.

Prerequisite: 24CET503 Environmental Engineering

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

CO 1	Outline the environmental legislations in India. (Understand Level)
CO 2	Explain the environmental clearance process in India. (Understand Level)
CO 3	Discuss the different EIA methodologies. (Understand Level)
CO 4	Describe environmental management plan and environmental audit. (Understand Level)
CO 5	Analyze EIA reports and conduct EIA. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	-	-	-	-	-	3	-	-	-	-	-	-
CO 2	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	-	-	-	-	-	1	-	-	-	-	-
CO 4	1	-	-	-	-	2	2	-	-	-	-	-
CO 5	2	-	-	-	1	-	1	-	2	2	-	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply			✓	
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Environmental Regulations)

Definition, Need for EIA, Evolution of EIA: Global & Indian scenario - Environmental legislations in India - The Water (Prevention & Control of Pollution) Act 1974, The Air (Prevention & Control of Pollution) Act 1981, The Environmental (Protection) Act 1986 - Environmental standards for water, air and noise quality - EIA Notification 1994, 2006 and subsequent amendments.

MODULE II (Environmental clearance process in India)

Environmental clearance process in India: Screening, Scoping, baseline data collection, Public Consultation, Appraisal - Form1- Category of projects - Generic structure of EIA report - Terms of Reference (ToR) -Types of EIA: strategic, regional,

sectoral, project level - Rapid EIA and Comprehensive EIA - Initial Environmental Examination (IEE).

MODULE III (EIA Methodologies)

EIA methodologies: Ad hoc, checklist, matrix, network (Fault Tree Analysis, Event Tree Analysis and HAZOP), overlay.
Impact Prediction, Evaluation and Mitigation: Prediction and assessment of the impact on water (surface water and groundwater), air, and noise environment - assessment of ecological impacts and Socio-economic impacts.

MODULE IV (Mitigation and Monitoring)

Environmental Management Plan (EMP): Goal and purpose - Importance of EMP - Content of an EMP - Role of environmental monitoring program.
Environment Audit: need for audit - audit types and benefits - environmental audit procedure.
ISO 14001 standards: Importance, salient features - Stages in implementation - Benefits.

MODULE V (Case Studies)

EIA case studies (Indian) - a highway project, a hydroelectric power plant, an airport project, a quarry mining project and a solid waste management project.
Application of RIAM software for impact assessment.

Text books

1. Anji M Mareddy, Environmental Impact Assessment- Theory and Practice, 2017, Elsevier.
2. Anjaneyulu Yerramilli, Valli Manickam, Environmental Impact Assessment Methodologies, 3rd edition, 2020, B S Publications.

Reference books

1. Larry W Canter, Environmental Impact Assessment, 1995, McGraw Hill Inc., New York.
2. Ministry of Environment & Forests, Govt. of India, EIA Notifications 1994, 2006 and amendments.
3. Ram B. Khadka, Steve Gorzula, Ananda R Joshi, Shailendra Guragain, and Ajay B. Mathema, Environmental Impact Assessment: Process, Methods and Practices of South Asia (Bangladesh, Bhutan, India and Nepal), 1st edition (2013), School of Environmental Science and Management (SchEMS) and Asian Environmental Solution, Nepal (AES/N).

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (35)
	MODULE 1 (4 hours)	
1.1	Definition, Need for EIA, Evolution of EIA: Global & Indian scenario.	1
1.2	Environmental legislations in India- The Water (Prevention & Control of Pollution) Act 1974, The Air (Prevention &	1

	Control of Pollution) Act 1981.	
1.3	The Environmental (Protection) Act 1986- Environmental standards for water, air and noise quality.	1
1.4	EIA Notification 1994, 2006 and subsequent amendments.	1
MODULE II (9 hours)		
2.1	Environmental clearance process in India – flowchart.	1
2.2	Screening.	1
2.3	Scoping.	1
2.4	baseline data collection.	1
2.5	Public Consultation.	1
2.6	Appraisal Form1-Category of projects- Generic structure of EIA report.	1
2.7	Terms of Reference (ToR).	1
2.8	Types of EIA: strategic, regional, sectoral, project level.	1
2.9	Rapid EIA and Comprehensive EIA - Initial Environmental Examination (IEE).	1
MODULE III (7 hours)		
3.1	EIA methodologies: Ad hoc, checklist.	1
3.2	Matrix, overlay.	1
3.3	Network (Fault Tree Analysis, Event Tree Analysis and HAZOP).	1
3.4	Impact Prediction, Evaluation and Mitigation.	1
3.5	Prediction and assessment of the impact on water (surface water and groundwater).	1
3.6	Prediction and assessment of the impact on air, and noise environment.	1
3.7	Assessment of ecological impacts and Socio-economic impacts.	1
MODULE IV (6 hours)		
4.1	Environmental Management Plan (EMP): Goal and purpose - Importance of EMP.	1

4.2	Content of an EMP - Role of environmental monitoring program.	1
4.3	Environment Audit: need for audit - audit types and benefits.	1
4.4	Environmental audit procedure.	1
4.5	ISO 14001 standards: Importance, salient features.	1
4.6	ISO 14001 standards: Stages in implementation – Benefits.	1
MODULE V (9 hours)		
5.1	EIA case studies on a highway project.	1
5.2	EIA case studies on a hydroelectric power plant.	1
5.3	EIA case studies on an airport project.	1
5.4	EIA case studies on a quarry mining project.	1
5.5	EIA case studies on a solid waste management project.	1
5.6	RIAM software study.	1
5.7	Application of RIAM software for impact assessment.	1
5.8	Application of RIAM software for impact assessment.	1
5.9	Application of RIAM software for impact assessment.	1

CO Assessment Questions	
CO1	Explain the environmental clearance process as per EIA notification 2006.
CO2	Explain screening. Describe the different ways of screening.
CO3	Enlist and explain the different types of checklists.
CO4	Discuss the importance of an EMP document.
CO5	Conduct an Impact analysis study for a road construction using RIAM.

24CEE674	TRAFFIC ENGINEERING AND MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: Traffic Engineering and Management is a comprehensive course designed to provide students with a fundamental understanding of the principles, theories, and practical applications of managing and optimizing traffic flow in urban and suburban environments. This course covers a wide range of topics related to traffic engineering, including traffic flow characteristics, traffic management strategies, capacity and level of service assessment, traffic control systems, intersections design, and traffic safety considerations. Students will develop the knowledge and skills necessary to address the complex challenges associated with urban mobility and traffic management.

Prerequisite: 24CEJ404 Transportation Engineering

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

CO 1	Interpret the effectiveness of traffic management measures for regulating and controlling traffic. (Understand level)
CO 2	Identify common safety issues and risk factors on roadways. (Understand level)
CO 3	Describe the basic principles of traffic flow and solve the fundamental relationship between parameters. (Understand and Apply level)
CO 4	Describe and calculate the roadway capacity for different road types. (Understand and Apply level)
CO 5	Summarise various types of intersections and solve the timings of signalized intersection. (Understand and Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	1	-	-	-	-	-	-	-	-	2
CO 4	3	3	1	-	-	-	-	-	-	-	-	-
CO 5	3	3	2	-	-	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Traffic flow characteristics)

Traffic Flow Characteristics: Fundamental Parameters - speed, density, volume, travel time, headway, spacing, time-space diagram, time mean speed, space mean speed and their relation. Fundamental diagrams of traffic flow. Greenshields model (Numerical example).

Traffic stream models: Single Regime models and multi-regime models (explanation only).

MODULE II (Traffic management and regulation strategies)

Traffic Management – scope of traffic management measures – restrictions to turning movements – one way streets – tidal flow operations-traffic calming – Exclusive bus lanes.

Regulation of Traffic - Need and scope of traffic regulations - Motor Vehicle Act –

Regulation of speed - Regulation of vehicles – Regulations concerning driver.
Introduction to Intelligent Transportation Systems.

MODULE III (Capacity and level of service assessment)

Capacity and Level of service (LOS): Concept- basic, possible and practical capacity, LOS definition, Factors Affecting Capacity and LOS, Concept of PCU.
HCM methods; Multilane highways: Characteristics, capacity and level of service. Basic freeway capacity, Two lane highway capacities, Multilane highway Capacity. (Numerical example)
Indo HCM (2017) Guidelines. (explanation only)

MODULE IV (Traffic safety considerations)

Traffic Safety: Causes of road accidents, influence of road, vehicle, driver and environmental factors.
Collection and Analysis of Accident Data, Condition and Collision Diagram, Causes and Remedies.
Statistical Methods in Traffic Safety Analysis.
Road Safety Audit- concept and need- stages of road safety audit (brief description only).

MODULE V (Traffic control systems and intersections design)

Intersections: At-grade intersections - basic forms - visibility triangle.
Roundabouts - Geometric layout, Capacity estimation.
Traffic Signals – Warrants.
Design of signal timing at isolated intersections - Phase design-optimum cycle time (Webster's approach), green splitting - pedestrian phase - phase diagrams.
Other Traffic Control Measures - Traffic Signs and Road Markings.
Coordinated traffic signal - Vehicle actuated signals and Area traffic control: Basic principles.

Text books

1. Kadiyali L.R. Traffic Engineering and Transport planning, Khanna Publishers, 2011.
2. Khanna S.K and Justo C.E.G; Highway Engineering, Nem Chand Publishers, 10th Ed, 2018.
3. Roger P. Roess, William R. McShane & Elena S. Prassas, Traffic Engineering, Fourth Edition, Prentice-Hall, 2010.

Reference books

1. CAO' Flaherty, Transport planning and Traffic Engineering, Elsevier, 2006.
2. Pignataro L. J., Traffic Engineering – Theory and Practice, Prentice Hall, 1973.
3. C. J. Khisty and B. K. Lall, Transportation Engineering: An Introduction, Prentice- Hall India, 2002.
4. P. Chakroborty and A. Das, Principles of Transportation Engineering, Prentice Hall of India Pvt. Ltd., 2003.
5. D. May, Traffic Flow Fundamentals, Prentice–Hall, 1990.
6. C.S. Papacostas, Transportation Engineering and Planning, Prentice-Hall

India, 2002.
7. Highway Capacity Manual (HCM), Transportation Research Board, USA, 2010.
8. Indian Highway Capacity Manual (Indo-HCM), CSIR, New Delhi, 2017.
9. Relevant IRC codes.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE 1 (7 hours)	
1.1	Introduction to Traffic Flow Characteristics.	1
1.2	Fundamental Parameters - speed, density, volume, travel time, headway, spacing.	1
1.3	Time mean speed, space mean speed and their relation – time - space diagram.	1
1.4	Fundamental Parameters – Numerical Example.	1
1.5	Fundamental diagrams of traffic flow - Greenshields model.	1
1.6	Greenshields model - Numerical example.	1
1.7	Traffic stream models: Single Regime models and multi-regime models.	1
	MODULE II (7 hours)	
2.1	Traffic Management – scope of traffic management measures.	1
2.2	Restrictions to turning movements – one way streets – tidal flow operations.	1
2.3	Traffic calming – Exclusive bus lanes.	1
2.4	Regulation of Traffic - Need and scope of traffic regulations.	1
2.5	Motor Vehicle Act – Regulation of speed.	1
2.6	Regulation of vehicles – Regulations concerning driver.	1
2.7	Introduction to Intelligent Transportation Systems.	1
	MODULE III (7 hours)	
3.1	Capacity and Level of service (LOS): Concept- basic, possible and practical capacity.	1

3.2	LOS definition, Factors Affecting Capacity and LOS.	1
3.3	Passenger Car Unit.	1
3.4	HCM methods; Multilane highways: Characteristics.	1
3.5	Basic freeway capacity - Two lane highway capacities.	1
3.6	Multilane highway Capacity - Numerical example.	1
3.7	Indo HCM (2017) Guidelines.	1
MODULE IV (7 hours)		
4.1	Traffic Safety: Causes of road accidents.	1
4.2	Influence of road, vehicle, driver and environmental factors.	1
4.3	Collection and Analysis of Accident Data.	1
4.4	Condition and Collision Diagram – Causes and remedies.	1
4.5	Statistical Methods in Traffic Safety Analysis.	1
4.6	Statistical Methods in Traffic Safety Analysis – Numerical example.	1
4.7	Road Safety Audit- concept and need- stages of road safety audit.	1
MODULE V (8 hours)		
5.1	Intersections: At-grade intersections - basic forms - visibility triangle.	1
5.2	Roundabouts - Geometric layout, Capacity estimation.	1
5.3	Traffic Signals –Warrants.	1
5.4	Design of signal timing at isolated intersections.	1
5.5	Phase design-optimum cycle time (Webster's approach), green splitting- pedestrian phase -phase diagrams.	1
5.6	Design of signal timing – Numerical example.	1
5.7	Other Traffic Control Measures - Traffic Signs and Road Markings.	1

5.8	Coordinated traffic signal - Vehicle actuated signals and Area traffic control: Basic principles.	1

CO Assessment Questions

CO1

1. Using basic stream flow diagram, explain speed-density, speed-flow and flow-density relationships.
2. Explain multi regime models citing examples.
3. The data shown below were obtained from a highway stretch. Fit these data to Greenshields model and determine:
   i) free speed ii) jam density iii) capacity and iv) speed at maximum flow.

Speed (km/h)	Density (veh/km)
14.2	85
24.1	70
30.3	55
40.1	41
50.6	20

CO2

1. Describe general principles governing speed limit in urban area and rural area.
2. Discuss the traffic management measures that can take care of the imbalance in directional distribution of traffic during peak hours.
3. Explain the aspects covered under regulation of vehicles and regulation concerning driver in motor vehicles act.

CO3

1. Explain the adjustment factors mentioned in Indo HCM (2017) that are to be considered in the capacity estimation of urban roads.
2. Differentiate base capacity and adjusted capacity.
3. Discuss the importance of passenger car units under heterogeneous traffic conditions.
4. Explain the concept of 'level of service' and identify the factors that influence capacity and level of service in transportation.

CO4

1. It has been found that on an average 1 in 100 drivers are involved in an accident every year. Calculate the probability of involvement of exactly 5 drivers out of the 500 drivers who are employed in a bus operating company in an accident during a year.
2. Explain the different methods for maintaining accident records? Briefly explain with neat sketches.
3. Explain various stages of road safety audit.
4. Explain any three statistical methods for analysis of accident data.

CO5

1. Explain briefly the various design factors that are to be considered in rotary intersection design.

2. Design a four phase signal timing plan for the data given below. The intersection is four legged. All approaches have 3 lanes and each lane is 3.5 m width. Saturation flow is 1800pcu/hr/lane. The equivalent hourly flows at the intersection are as shown below: Using the Webster model, determine the optimal cycle length for the intersection. Assume lost times equal to 3.5 s/phase, amber interval equal to 3 s, and all red period is not provided. Also draw the phase and timing diagram.

East bound			West bound			North bound			South bound		
L	T	R	L	T	R	L	T	R	L	T	R
280	850	80	320	700	120	50	280	40	35	360	10

PROFESSIONAL ELECTIVE – 2/ INDUSTRIAL ELECTIVE

24CEI615	PRE-ENGINEERED STRUCTURES	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to impart knowledge about pre-engineered buildings (PEB), their analysis and design for different conditions. It enhances the knowledge of students to identify the components of PEB, estimate the loads acting on PEB and understand the design parameters of pre-engineered structures. After this course, students will be able to analyze, design and check the structural stability of Pre-engineered structures.

Prerequisite: Nil

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Interpret the concepts of pre-engineered buildings (PEB) and differentiate between conventional steel buildings. (Understand level)
CO2	Distinguish the functions of PEB components like Primary system, Secondary system, and Bracing system. (Understand level)
CO3	Calculate the design loads on pre-engineered buildings. (Apply level)
CO4	Apply the design methodology of PEB Frames. (Apply level)
CO5	Estimate the strength of connections and design the connections adopted in PEB Frames. (Understand and Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	3	-	-	-	-	2	-	-	-	-	-	-
CO4	3	3	-	-	-	2	-	-	-	-	-	-
CO5	3	3	-	-	-	2	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L-T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

Module I (Introduction to Pre-Engineered Buildings)

Introduction – History – Advantages of PEB – Applications of PEB – Materials used for manufacturing of PEB. Difference between Conventional Steel Buildings and Pre-Engineered buildings.

Module II (Pre-Engineered Building Components)

Primary System: Main frames, Gable End Frame; Secondary frame system: Sizes and Properties of Purlins & Girts; Bracing System: Rod, angle, Portal, Pipe bracing;

Sheeting and Cladding: Roof Sheeting and Wall sheeting; Accessories: Turbo Ventilators, Ridge vents, Sky Lights, Louvers, Insulation, Stair cases.
Module III (Design Loads on Pre-Engineered Buildings)
Analysis of PEB frame under the influence of Dead, Live, Collateral, Wind, Seismic and Other applicable Loads. Serviceability Limits as per code.
Module IV (PEB Design Methodology)
Design Parameters of PEB Frames – Depth of the section, Depth to Flange width ratios, Thickness of Flange to thickness of Web ratio. d/t_w, b_f/t_f ratios of sections as per IS code. Section Sizes as per Manufacturing Limitations. Analysis and Design of Rigid Frames.
Module V (PEB Frame Connection Design)
Rigid Frame Moment Connection, Shear Connection, High Strength Bolts, Different types of bolts & grades, Lever arm, Bolt pattern and its effect on connection design, Design of connection plate and base plate: thickness of connection plate, base plate size, Selection of governing forces for connection design.
Text Books: 1. Newman A., Metal Building Systems, Design and Specifications, 3rd Edition, McGraw Hill Education, 2014. 2. Vivek K. S., and P. Vaishavi, Pre-Engineered Steel Buildings, Lambert Academic Publishing, 2017. **Reference Books:** 1. Subramanian A. P., and H. S. Subramanian, Pre-Engineered Building (PEB) And Rules of Thumb for Steel Design (PEB), 2021. 2. Panda S. K., Pre-Engineered Metal Building Structure Installation Handbook, Lambert Academic Publishing, 2021.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (33)
Module 1 (4 Hours)		
1.1	Introduction and History of PEB.	1
1.2	Advantages of PEB, Applications of PEB.	1
1.3	Materials used for manufacturing of PEB.	1
1.4	Difference between Conventional Steel Buildings and Pre-Engineered buildings.	1
Module II (6 Hours)		

2.1	Primary System: Main frames, Gable End Frame.	1
2.2	Secondary frame system: Sizes and Properties of Purlins & Girts.	1
2.3	Bracing System: Rod, angle, Portal, Pipe bracing.	1
2.4	Sheeting and Cladding: Roof Sheeting and Wall sheeting.	1
2.5	Accessories: Turbo Ventilators, Ridge vents, Sky Lights.	1
2.6	Accessories: Louvers, Insulation, Stair cases.	1
Module III (7 Hours)		
3.1	Analysis of PEB frame under the influence of Dead, Live, Collateral, Wind, Seismic and Other applicable Loads.	1
3.2	Problems on combined loads including (WL + EQL) on PEB frames.	1
3.3	Problems on combined loads including (WL + EQL) on PEB frames.	1
3.4	Problems on combined loads including (WL + EQL) on PEB frames.	1
3.5	Serviceability Limits as per code.	1
3.6	Problem including serviceability limits.	1
3.7	Problem including serviceability limits.	1
Module IV (8 Hours)		
4.1	Design Parameters of PEB Frames - Depth of the section, Depth to Flange width ratios, Thickness of Flange to thickness of Web ratio. d/t_w, b_f/t_f ratios of sections as per IS code. Section Sizes as per Manufacturing Limitations.	1
4.2	Design Parameters of PEB Frames - Depth of the section, Section Sizes as per Manufacturing Limitations.	1
4.3	Analysis of Rigid Frames.	1
4.4	Analysis of Rigid Frames.	1
4.5	Analysis of Rigid Frames.	1
4.6	Problems on design of rigid frames.	1
4.7	Problems on design of rigid frames.	1
4.8	Problems on design of rigid frames.	1
Module V (8 Hours)		
5.1	Rigid Frame Moment Connection.	1

5.2	Rigid Frame Shear Connection.	1
5.3	High Strength Bolts.	1
5.4	Different types of bolts & grades, Lever arm.	1
5.5	Bolt pattern its effect on connection design.	1
5.6	Connection plate design.	1
5.7	Base plate design.	1
5.8	Selection of governing forces for connection design.	1

CO 1	Differentiate between pre-engineered buildings and conventional steel buildings.
CO 2	Discuss the components of pre-engineered buildings.
CO 3	For a pre-engineered building with a clear span of 40 meters and a roof slope of 1:10, calculate the total gravity load on the roof. Assume a roof dead load of 25 kg/m² and a live load of 150 kg/m². Additionally, consider the weight of the purlins and other roofing materials.
CO 4	A pre-engineered building with rigid frame for an industrial facility have the following specifications: Building Dimensions: Width = 30 meters, Length = 60 meters, Height = 8 meters. Roof Slope: 1:10. Wind Load: The site is located in a region with a wind speed of 150 km/h. Calculate the wind load acting on the building. Also, determine the seismic design parameters based on the site's seismic zone, and calculate the seismic forces on the structure.
CO 5	Two flats (Fe 410 Grade Steel), each 210 mm × 8 mm, are to be jointed using 20 mm diameter, 4.6 grade bolts, to form a lap joint. The joint is supposed to transfer a factored load of 250 kN. a) Calculate the strength of the joint. b) Design the joint and determine suitable pitch for the bolts.

24CEE625	HOUSING PLANNING & MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of the course is to train the students to have a comprehensive knowledge of housing projects, emphasising on the principles of sustainable housing policies and programmes. The course focuses on cost effective construction materials and methods. After this course students will be able to infer plan, design, evaluate, construct and financing of housing projects.

Prerequisite: Nil

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Recall basic terms of housing, housing laws and control regulations. (Remember level)
CO2	Identify the role of public, private and non-government organizations. (Understand level)
CO3	Identify the different types of sites and excel in design and evaluation. (Understand level)
CO4	Identify the effective materials for construction. (Understand level)
CO5	Interpret neighborhood and cluster planning principles, comply with national building codes and guidelines, and design living spaces. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	1	-	-	-	-	-	-
CO2	1	-	-	-	-	1	-	-	-	-	-	-
CO3	1	-	-	-	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-	-
CO5	2	-	-	-	-	2	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS
Module I (Introduction to Housing)
Definition of Basic Terms, Objectives and Strategies of National Housing Policies including Slum Housing Policy, Principle of Sustainable Housing – Integrated approach on arriving holding capacity and density norms, Institutions for Housing at National, State and Local levels.
Module II (Housing Programmes)

Basic Concepts, Contents and Standards for Housing Programmes, Co-operative Housing, Slum Housing Programmes – Slum improvement – Slum redevelopment and Relocation – Role of Non-Government Organizations in slum housing.

Module III (Planning and Design of Housing Projects)

Formulation of Housing Projects – Land Use and Soil suitability analysis - Building Byelaws and Rules and Development Control Regulations - Site Analysis, Layout Design, Design of Housing Units (Design Problems) – Housing Project Formulation – Evaluation of Housing Projects for sustainable principles – Housing Finance.

Module IV (Construction Techniques and Cost-Effective Materials)

New Constructions Techniques – Cost Effective Modern Materials and Methods of Construction - Green building concept. Green Housing, Sustainable housing, Green Ratings (LEEDS, GRIHA etc.). Climatology in Housing, Ventilation & Lighting.

Module V (Theories and Approaches in Housing)

Housing in various climatic regions. Low-rise and high-rise developments, density considerations, Neighbourhood & cluster considerations in traditional and contemporary housing. Housing Norms and Standards: National Building Code, URDPFI Guidelines, CPHEEO (MoUD) Standards, Concept of Habitable Room, Habitable Dwelling Unit.

Text Books:

1. Meera Mehta and Dinesh Mehta, “Metropolitan Housing Markets”, Sage Publications Pvt. Ltd., New Delhi, 1999.
2. Francis Cherunilam and Odeyar D Heggade, “Housing in India”, Himalaya Publishing House, Bombay, 1997.

Reference Books:

1. Wiley- Blackwell, “Neufert Architects” Data, 4th Edition, Blackwell Publishing Ltd, 2012.
2. Donald Watson and Michael J.Crosbie, “Time Saver Standards for Architectural Design”, 8th Edition, Tata McGraw Hill Edition, 2011.
3. Walter Martin Hosack, “Land Development Calculations”, McGraw Hill 2nd Edition, USA 2010.
4. Al Nichols, Jason Laros. Inside the Civano Project (Green Source Books): A Case study of LargeScale Sustainable Neighbourhood Development (McGraw-Hill’s Green source Series) 2009 McGraw – Hills Professional.
5. UNCHS, National Experiences with Shelter Delivery for the Poorest Groups, UNCHS Habitat, Nairobi, 1994.
6. Government of India, National Housing Policy, 1994.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	Module I (8 Hours)	
1.1	Definition of Basic Terms.	1
1.2	Objectives and Strategies of National Housing Policies.	1

1.3	Slum Housing Policy.	1
1.4	Principle of Sustainable Housing.	1
1.5	Integrated approach on arriving holding capacity and density norms.	1
1.6	Institutions for Housing at National, State and Local levels.	1
1.7	Institutions for Housing at State levels.	1
1.8	Institutions for Housing at Local levels.	1
Module II (7 Hours)		
2.1	Basic Concepts, Contents and Standards for Housing Programmes.	1
2.2	Co-operative Housing.	1
2.3	Slum Housing Programmes.	1
2.4	Slum improvement.	1
2.5	Slum redevelopment and Relocation.	1
2.6	Use of GIS and MIS in Slum Housing Projects.	1
2.7	Role of Non-Government Organizations in slum housing.	1
Module III (7 Hours)		
3.1	Formulation of Housing Projects.	1
3.2	Land Use and Soil suitability analysis.	1
3.3	Building Byelaws and Rules.	1
3.4	Development Control Regulations.	1
3.5	Site Analysis, Layout Design.	1
3.6	Design of Housing Units.	1
3.7	Housing Project Formulation.	1
Module IV (7 Hours)		
4.1	New Construction Techniques- Precast and Prefab technologies, GFRG, LGSF, Pre-Engineered Buildings.	1
4.2	Cost Effective Modern Materials- Wood, Bamboo, Concrete sheets, self-healing concrete, Prefab panels.	1
4.3	Methods of Construction- Precast Flat Panel System, 3D Volumetric Construction, Flat Slab Construction, Precast Concrete Foundations.	1
4.4	Green building concept.	1

4.5	Green Housing, Sustainable housing.	1
4.5	Green Ratings (LEEDS, GRIHA etc.).	1
4.6	Climatology in Housing, Ventilation & Lighting.	1
Module V (7 Hours)		
5.1	Housing in various climatic regions.	1
5.2	Low-rise and high-rise developments, density considerations.	1
5.3	Neighbourhood & cluster considerations in traditional and contemporary housing.	1
5.4	Housing Norms and Standards.	1
5.5	Housing Norms and Standards.	1
5.6	Concept of Habitable Room.	1
5.7	Habitable Dwelling Unit.	1

CO Assessment Questions		
CO 1	1	Define housing.
	2	Write in detail about institutions of housing schemes.
CO 2	1	Describe the agencies for housing.
	2	Explain the role of Non-Government Organizations in slum housing.
CO 3	1	Define site analysis.
	2	Explain the factors considered for housing unit.
CO 4	1	Elaborate on the performance evaluation of construction techniques?
	2	Write in detail on Green building concept.
CO 5	1	Briefly explain the following with reference to Housing Finance. i) Housing Finance system in India ii) Design of Housing Units.

24CEI635	CONSTRUCTION METHODS AND EQUIPMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this comprehensive course is to familiarize students with a wide spectrum of construction techniques, equipment, and methodologies necessary for efficient and successful large-scale construction projects. Our primary goal is to provide an in-depth understanding of various construction processes, equipment functionalities, and their applications in complex structures, including tall buildings, bridges, tunnels, and substructures. By the end of the course, students will possess the expertise to select the appropriate construction techniques, equipment, and methodologies for different project requirements, facilitating their readiness to contribute effectively to the construction industry.

Prerequisite: Nil

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

CO1	Explain the various construction procedures for substructures and super structures. (Understand level)
CO2	Describe the various construction activities involved in underground and under water construction. (Understand level)
CO3	Demonstrate basic knowledge about construction equipment and machineries. (Understand level)
CO4	Explain the equipment used for production of aggregates and concreting. (Understand level)
CO5	Select construction equipment appropriate to tasks. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-
CO 4	3	1	-	-	-	-	-	-	-	-	-	-
CO 5	3	1	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Construction Techniques)

Construction joints - movement and expansion joints – Vacuum Dewatering of Concrete Flooring – Techniques of construction for continuous concreting operation in Tall buildings – Slip Form techniques — Erection techniques of Tall structures, large Span Structures - Bridge Construction: Construction sequence and methods - Bow string bridges, cable stayed bridges - Launching techniques for heavy decks. Domes - Types — Construction sequence and methods in domes.

MODULE II (Substructure Construction)

Tunneling techniques - Piling techniques - driving well and caisson - sinking cofferdam - cable anchoring and grouting. Driving diaphragm walls, sheet piles - shoring for deep cutting - well points - dewatering and stand by Plant equipment for underground open excavation.

MODULE III (Equipment for Earthwork)

Fundamentals of earthwork operations - earth moving operations - types of earthwork

equipment - tractors, motor graders, scrapers, front end waders – excavating and earth moving equipment - dozer, excavators, rippers, loaders - trucks and hauling equipment, compacting equipment, finishing equipment.

MODULE IV (Equipment for Production of Aggregate and Concrete)

Equipment for production of aggregate and concreting - Crushers – Feeders - Screening Equipment – Handling Equipment - Batching and Mixing Equipment - Transit mixers - Hauling, Concrete Pouring and Pumping Equipment – Transporters.

MODULE V (Other Construction Equipment)

Pile driving Equipment - Erection Equipment – Cranes, Derrick Cranes, Mobile cranes, Overhead cranes, Traveller cranes, Tower cranes - Types of pumps used in Construction - Equipment for Dewatering and Grouting - Material Handling Conveyors – Industrial Trucks, Forklifts and related equipment.

Text books

1. Peurifoy, R.L., Ledbetter, W.B. and Schexnayder, C., "Construction Planning, Equipment and Methods", McGraw Hill, Singapore, 2006.
2. Sharma S.C. "Construction Equipment and Management", Khanna Publishers, New Delhi, 1988.
3. Arora S.P. and Bindra S.P., Building Construction, Planning Techniques and Method of Construction, Dhanpat Rai and Sons, 1997.

Reference books

1. Deodhar, S.V. "Construction Equipment and Job Planning", Khanna Publishers, New Delhi,1988.
2. Jerry Irvine, Advanced Construction Techniques, CA Rocketry, 1984.
3. Dr. Mahesh Varma, "Construction Equipment and its planning and Application", Metropolitan Book Company, New Delhi, 1983.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (6 hours)	
1.1	Construction joints - movement and expansion joints.	1
1.2	Vacuum Dewatering of Concrete Flooring – Techniques of construction for continuous concreting operation in Tall buildings – Slip Form techniques.	1
1.3	Erection techniques of Tall structures, Large Span Structures.	1
1.4	Bridge Construction: Construction sequence and methods.	1
1.5	Bow string bridges, cable stayed bridges - Launching techniques for heavy decks.	1
1.6	Domes - Types — Construction sequence and methods in domes.	1

MODULE II (7 hours)		
2.1	Tunneling techniques.	1
2.2	Piling techniques - driving well and caisson.	1
2.3	sinking cofferdam.	1
2.4	Cable anchoring and grouting.	1
2.5	Driving diaphragm walls, sheet piles.	1
2.6	Shoring for deep cutting - well points.	1
2.7	Dewatering and stand by Plant equipment for underground open excavation.	1
MODULE III (8 hours)		
3.1	Fundamentals of earthwork operations - earth moving operations.	1
3.2	types of earthwork equipment - tractors, motor graders.	1
3.3	scrapers, front end waders.	1
3.4	Excavating and earth moving equipment.	1
3.5	Dozer, excavators.	1
3.6	Rippers, loaders.	1
3.7	Trucks and hauling equipment.	1
3.8	compacting equipment, finishing equipment.	1
MODULE IV (7 hours)		
4.1	Equipment for production of aggregate and concreting.	1
4.2	Crushers – Feeders.	1
4.3	Screening Equipment.	1
4.4	Handling Equipment.	1
4.5	Batching and Mixing Equipment- Transit mixers.	1
4.6	Hauling, Concrete Pouring and pumping equipment.	1
4.7	Pouring and pumping Equipment – Transporters.	1
MODULE V (8 hours)		
5.1	Pile driving Equipment.	1

5.2	Erection Equipment – Cranes, Derrick Cranes.	1
5.3	Mobile cranes, Overhead cranes.	1
5.4	Traveller cranes, Tower cranes.	1
5.5	Types of pumps used in Construction.	1
5.6	Equipment for Dewatering and Grouting.	1
5.7	Material Handling Conveyors.	1
5.8	Industrial Trucks, Forklifts and related equipment.	1

CO Assessment Questions	
CO1	1. Explain the various types of construction joints. 2. Write short notes on vacuum dewatering of concrete flooring. 3. What is a slip form? Where they are used? 4. Discuss in detail various techniques used for launching heavy decks. 5. Discuss the construction methods of cable stayed bridges. 6. Explain the procedure involved in the construction of domes.
CO2	1. Describe the procedure involved in the Piling technique. 2. What is a cofferdam? With the help of sketches explain various types of Cofferdams. 3. Explain the uses of diaphragm walls and sheet piles. 4. Write short notes on well foundation and caisson. 5. Explain the methods of dewatering foundations excavations
CO3	1. Discuss different types of earthwork operations. 2. Explain the uses of various types of excavating equipment. 3. Explain the pile driving equipment in detail. 4. Describe the various equipment used for compaction in field.
CO4	1. Explain the types of crushers used for production of aggregates. 2. Describe the uses of screening equipment. 3. Discuss different types of Mixers used for concrete mixing. 4. Explain the types of Pumps used in concrete construction.
CO5	1. Mention the various types of earthwork equipment. Explain their uses. 2. Discuss the role of tractors in earth moving. What consideration govern selection of wheel type or crawler type tractor on a job? 3. What are the different types of cranes? Explain them in detail. 4. What are the advantages of using belt conveyors for transporting materials? 5. Compare the applications of various equipment used for compaction.

24CE1645	VALUATION OF IMMOVABLE PROPERTIES	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble:

This course introduces the principles and methodologies involved in the valuation of immovable property. It covers fundamental concepts in real estate appraisal, exploring various approaches to property valuation, market analysis, and regulatory considerations. Through theoretical discussions, case studies, and practical exercises, students will gain the skills and knowledge necessary to assess the value of different types of real estate.

Prerequisite: Nil

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Define the technical terms involved in valuation of immovable properties [Understand level]
CO2	Identify the return on investment on immovable property [Apply level]
CO3	Calculate the standard rent of buildings [Apply level]
CO4	Prepare valuation of land and buildings [Apply level]
CO5	Recall the important aspects of Acts related to valuation [Remember level]

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-		-		-	-
CO2	3	-	-	-	-	-	-		-		-	-
CO3	3	2	-	-	-	-	-		-		-	-
CO4	3	2	-	-	-	-	-		-	2	-	-
CO5	-	-	-	-	-	-	-	2	-		-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS
Module I (Valuation Principles)
Purpose – doctrine of estate – different form of value – factors affecting, aspects, characteristics. Supply and demand forces, factors affecting demand and supply–Cost, Price & Value Type of interest (right) in land-Free hold-Lease hold, Forms of lease, Mortgage Income, Outgoings-Type, sinking fund, Year's Purchase Numerical examples. Valuation table – use.
Module II (Investments & return)
Investment – Type – characteristics of ideal investment

Appraisal technique – Net present value (NPV) by discounted cash flow method (DCF), Internal rate of return (IRR) – Numerical Example.

Life of various types of buildings – Depreciation – Obsolescence – Functional & Economical -difference between depreciation and obsolescence

Method of estimating cost depreciation-Numerical examples.

Module III (Rent fixation & Valuation of Land)

Standard Rent-objects of rent Act – Important factors-methods for ascertaining standard rent-Comparative method & investment theory-Numerical examples

Method of Valuation for open land – Comparative method, Abstractive method, Belting method-Numerical examples

Valuation for bank-Purposes – Security, Primary and collateral.

Module IV (Valuation of land with building & Reporting)

Building FSI – Plot coverage – Types of structure

Method of valuation of land with buildings – Rental method, direct comparison of the capital, Valuation based on profit- Numerical examples

Valuation of apartment – FSI – Super built-up area, Undivided share of land

Environment & Valuation – Environmental factors affecting valuation

Report writing for various purposes of valuation-Sale, Purchase, Mortgage, Taxation, Insurance, Liquidation etc.

Valuation report based on a case study.

Module V (Valuer Profession, Act & Rules)

Role of valuer – Classification-Valuers' Functions & Responsibilities, Error of Judgement and Professional Negligence

Professional ethics – Model Code of Conduct as notified by MCA under the Companies (Registered valuers and valuation) Rules 2017 - Ethical considerations under terms of engagements

Salient features of Real estate (regulation & development) Act 2016, Transfer of property Act, Land acquisition, Indian easement Act,

Estate Duty Act of 1953, Wealth Tax Act of 1957, Gift Tax Act of 1958, Income Tax Act of 1964, Rating Laws of 1866 (brief description only)

Important case laws – Case study based on case laws

CPWD Rates, Cost Index, Cost Inflation Index

Valuation for Capital Gain Tax-Numerical examples

Text books

1. P.T.Hardikar, Basics in Real Estate Valuation, 2022.
2. David Ling and Wayne Archer , Real estate principles : A Value approach, Fifth Edition, McGraw-Hill Education, 2018.

Reference books

1. The appraisal of real estate, 15th Edition, Appraisers Institute of Real Estate American, 2020.
2. Rangwala, Valuation of Real properties, Charotar Publishing House Pvt. Ltd., 2020.
3. R. Martha Williams & L. William Ventolo, Fundamentals of Real Estate Appraisal, Eighth Edition, Dearbon Real Estate Education, 2001.
4. CPWD-DSR

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36)
Module 1 (7 Hours)		
1.1	Purpose of valuation-doctrine of estate.	1
1.2	Different form of value-factors affecting, aspects, characteristics.	1
1.3	Supply and demand forces, factors affecting demand and supply-Cost, Price & Value.	1
1.4	Type of interest (right) in land-Free hold-Lease hold, Forms of lease, Mortgage.	1
1.5	Income, Outgoings-Type.	1
1.6	Sinking fund, Year's Purchase Numerical examples.	1
1.7	Valuation table-use.	1
Module 2 (7 Hours)		
2.1	Investment – Type – characteristics of ideal investment.	1
2.2	Appraisal technique – Net present value (NPV) by discounted cash flow method. (DCF)	1
2.3	Internal rate of return. (IRR)	1
2.4	Numerical Example.	1
2.5	Life of various types of buildings -Depreciation- Obsolescence-Functional & Economical -difference between depreciation and obsolescence.	1
2.6	Method of estimating cost depreciation.	1
2.7	Numerical examples.	1
Module 3 (7 Hours)		
3.1	Standard Rent-objects of rent Act- Important factors.	1
3.2	Methods for ascertaining -Comparative method & investment theory.	1
3.3	Standard rent -Numerical examples.	1
3.4	Method of Valuation for open land- Comparative method- Abstractive method.	1
3.5	Numerical examples.	1
3.6	Belting method-Numerical examples.	1
3.7	Valuation for bank-Purposes – Security, Primary and collateral.	1
Module 4 (8 Hours)		
4.1	Building FSI – Plot coverage – Types of structure.	1
4.2	Method of valuation of land with buildings- Rental method, direct comparison of the capital, Valuation based on profit.	1

4.3	Valuation of apartment-FSI – Super built-up area, Undivided share of land.	1
4.4	Method of valuation of land with buildings -Numerical examples.	1
4.5	Environment & Valuation- Environmental factors affecting valuation.	1
4.6	Report writing for various purposes of valuation-Sale, Purchase, Mortgage, Taxation, Insurance, Liquidation etc.	1
4.7	Prepare valuation report based on a case study.	1
4.8	Prepare valuation report based on a case study.	1
Module 5 (7 Hours)		
5.1	Role of valuer-Classification-Valuers' Functions & Responsibilities, Error of Judgement and Professional Negligence.	1
5.2	Professional ethics- Model Code of Conduct as notified by MCA under the Companies (Registered valuers and valuation) Rules 2017 - Ethical considerations under terms of engagements.	1
5.3	Salient features of Real estate (regulation & development) Act 2016, Transfer of property Act, Land acquisition, Indian easement Act.	1
5.4	Estate Duty Act of 1953, Wealth Tax Act of 1957, Gift Tax Act of 1958, Income Tax Act of 1964, Rating Laws of 1866. (brief description only)	1
5.5	Important case laws-Case study based on case laws.	1
5.6	CPWD Rates, Cost Index, Cost Inflation Index Valuation for Capital Gain Tax.	1
5.7	Valuation for Capital Gain Tax-Numerical examples.	1

CO Assessment Questions	
CO1	List the factors affecting valuation. Explain the significance of sinking fund. How is it calculated?
CO2	Calculate the net present value (NPV) for a project involving the acquisition of a building at a cost of Rs. 15,00,000, with Rs. 5,00,000 spent on maintenance. The building is expected to generate annual rent of Rs. 30,000/year for five years and then be sold for Rs. 18,00,000. The target rate is 12%, and a capital gain tax of Rs. 1,00,000 needs to be paid.
CO3	A new building consisting of four flats was constructed at a total cost of Rs. 50,00,000 (including sanitary and water supply works, electrical installation, etc.), on a plot of land costing Rs. 15,00,000. The owner expects a 7% return on the cost of construction and a 5% return on the cost of the land. Determine the standard rent for each flat of the building, under the assumption that the building has a lifespan of 60 years, and a sinking fund will be created on a 4% interest basis. Also, assume that the annual repair cost is 1% of the construction cost, and other outgoings (including taxes) are at 30% of the net return on the building.

CO4	Workout the valuation of a commercial building with the following data: Cost of land for life-time period of building is ₹.5,20,000/-. Gross income per year is ₹.8,50,000/-Expenses required per year: (a) staff salary, electric charges, municipal taxes including licenses fees, stationery and printing etc. is 20% of the gross income. (b) For repair and maintenance of lift, furniture etc. @ 5% of their capital cost of ₹.10,50,000/- (c) sinking fund for the items considered in capital cost, whose life is 25years @ 4% after allowing 10% scrap value. (d) Insurance premium is ₹.25,000/- per year. Take year's purchase @8% and annual repair of the building @2% on gross income
CO5	Describe the six types of mortgage recognized by the Transfer of Property Act. List the basic principles of The Land Acquisition Act, 1894

24CEI655	REINFORCED SOIL STRUCTURES AND GEOSYNTHETICS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The goal of the course is to explain the principle and mechanism of reinforced soil. The course covers different types of geosynthetics, their properties, functions and applications. The course enables students to apply the concept of reinforced soil in the design of reinforced soil retaining walls, reinforced earth beds and reinforced pavements.

Prerequisite: 24CEJ502 Foundation Engineering

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

CO1	Explain the history and mechanism of reinforced soil. (Understand and Apply Level)
CO2	Describe various types of geosynthetics and their properties. (Remember and Understand Level)
CO3	Identify the applications of geosynthetics based on their functions. (Remember and Understand Level)
CO4	Explain the design of reinforced earth beds and reinforced pavements. (Remember and Understand Level)
CO5	Apply the concept of reinforced earth in the design of reinforced soil retaining walls. (Understand and Apply Level)

CO – PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	2	-	-	-	-	-	-	-	-	-	-	2
CO3	3	1	-	2	-	-	-	-	-	-	-	2
CO4	3	3	-	2	-	-	-	-	-	-	-	1
CO5	3	3	-	3	-	-	-	-	-	-	-	1

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hrs

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Overview of Reinforced Soil and Geosynthetics)

Introduction - history of reinforced soil – ancient and modern structures, Reinforced soil – Principle, Types of geosynthetics and their applications such as use in retaining walls, slopes, embankments, railway tracks, pavements, landfills etc. (General overview)

Raw materials used for geosynthetics, Manufacturing process of woven and non-woven geotextiles, geomembranes, geogrids. Properties of geosynthetics. Creep and long-term performance.

MODULE II (Mechanism of Reinforced Soil)

Mechanism of reinforcement action - Strength of reinforced soil - Equivalent Confining Stress Concept, Pseudo Cohesion Concept, Concept of Expanding soil mass. Simple problems.

Soil retaining structures - Types, Components, Fill material, Facings, Factors affecting the performance of reinforced soil structures.

MODULE III (Analysis and Design of Reinforced Soil Retaining Walls)

Construction methods of reinforced retaining walls, Design codes for Reinforced Soil Retaining Walls. Analysis of vertically faced reinforced soil retaining walls - External stability and Internal stability – Tie back wedge analysis and coherent gravity analysis - Assumptions, limitations and numerical problems.

Design of Reinforced Soil Retaining Walls – simple geometry. (Numerical problems)

MODULE IV (Geosynthetics in Soil Beds and Pavements)

Bearing capacity improvement using soil reinforcement – Binquet and Lee's analysis – Assumptions, failure mechanisms. Numerical problems in bearing capacity.

Geosynthetics in pavements - functions and benefits - design approaches - Giroud and Noiray approach - Numerical problems.

MODULE V (Geosynthetics for Filtration, Drainage and Erosion Control)

Geosynthetics in filtration, drainage and erosion control, Natural geosynthetics and their applications.

Concept of Prefabricated vertical drains, Geocells, Gabion Walls, encased stone columns, geocomposites, soil nailing, geotubes, geobags. (only basic concepts)

Text books

1. Jones, C.J.F.P. (2010) Earth Reinforcement and Soil Structures, Thomas Telford, London, U.K.
2. Koerner, R.M. (1999). Designing with Geosynthetics, Prentice Hall, New Jersey, USA, 4th edition.

Reference books

1. Rao, G.V. (2007). Geosynthetics – An Introduction. Sai Master Geoenvironmental Services Pvt. Ltd., Hyderabad.

2. Rao, G.V., Kumar, S. J. and Raju, G.V.S.S. (Eds.). Earth Reinforcement – Design and Construction. Publication No. 314, Central Board of Irrigation and Power, New Delhi, 2012.
3. Sivakumar Babu, G.L. (2006). An introduction to Soil reinforcement and geosynthetics. United Press (India) Pvt. Ltd.
4. Jewell, R.A. (1996) Soil reinforcement with geotextiles, CIRIA & Thomas Telford, London, U.K.
5. Saran, Swami (2006) Reinforced Soil and its Engineering Applications, I.K. International, New Delhi.
6. Shukla, S.K. (2012) Handbook of Geosynthetic Engineering, 2nd Edition, ICE Publishing, London, U.K.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (7 Hours)	
1.1	Introduction -history of reinforced soil, Ancient and modern structures, Reinforced soil – Principle.	1
1.2	Types of geosynthetics and their applications in retaining walls, slopes, embankments, railway tracks, pavements, landfills etc. (General overview)	1
1.3	Raw materials used for geosynthetics, Manufacturing process of woven and non-woven geotextiles.	1
1.4	Manufacturing process of geomembranes and geogrids.	1
1.5	Properties of geosynthetics.	1
1.6	Properties of geosynthetics.	1
1.7	Creep and long-term performance.	1
	MODULE II (6 Hours)	
2.1	Mechanism of reinforcement action - Strength of reinforced soil- Equivalent Confining Stress Concept.	1
2.2	Pseudo Cohesion Concept.	1
2.3	Concept of Expanding soil mass.	1
2.4	Numerical problems on the concepts.	1

2.5	Soil retaining structures- Types, Components, Fill material.	1
2.6	Facings, Factors affecting the performance of reinforced soil structures.	1
	MODULE III (7 Hours)	
3.1	Construction methods of reinforced retaining walls.	1
3.2	Design codes for Reinforced Soil Retaining Walls.	1
3.3	Analysis of vertically faced reinforced soil retaining walls - External stability and Internal stability.	1
3.4	Tie back wedge analysis - Assumptions, limitations and numerical problems.	1
3.5	Coherent gravity analysis - Assumptions, limitations and numerical problems.	1
3.6	Design of Reinforced Soil Retaining Walls – simple geometry. (Numerical problems)	1
3.7	Design of Reinforced Soil Retaining Walls – simple geometry. (Numerical problems)	1
	MODULE IV (7 Hours)	
4.1	Bearing capacity improvement using soil reinforcement – Binquet and Lee's analysis – Assumptions, failure mechanisms.	1
4.2	Numerical problems on bearing capacity improvement using soil reinforcement.	1
4.3	Numerical problems on bearing capacity improvement using soil reinforcement.	1
4.4	Geosynthetics in pavements-functions and benefits.	1
4.5	Geosynthetics in pavements-design approaches- Giroud and Noiray approach.	1
4.6	Numerical problems. (Giroud and Noiray approach)	1
4.7	Numerical problems. (Giroud and Noiray approach)	1

MODULE V (9 Hours)		
5.1	Geosynthetics in filtration.	1
5.2	Geosynthetics in drainage.	1
5.3	Geosynthetics in erosion control.	1
5.4	Natural geosynthetics and their applications.	1
5.5	Concept of Prefabricated vertical drains. (only basic concepts)	1
5.6	Concept of encased stone columns. (only basic concepts)	1
5.7	Concept of Gabion Walls. (only basic concepts)	1
5.8	Concept of soil nailing. (only basic concepts)	1
5.9	Concept of Geocomposites, geotubes, geobags. (only basic concepts)	1

CO Assessment Questions	
CO1	1. Explain the historical applications of reinforced soil. 2. The tensile capacity of a single reinforcement layer is given as 40kN/m. The horizontal and vertical spacing of the reinforcement are 0.3m and 0.5m respectively. Calculate the apparent cohesion if angle of internal friction of backfill is 30˚.
CO2	Describe the long-term tensile strength loss of geosynthetic reinforcement.
CO3	Explain how the geosynthetics help to strengthen the following with neat sketches. (a) A rutted unpaved road (b) The pavement above a sink hole (c) Embankment on a soft soil (d) Steep slopes
CO4	Explain the modes of bearing capacity failure in Binquet and Lee's analysis of reinforced soil bed.
CO5	A reinforced soil wall of 8 m height carries a surcharge load of 30 kPa. The soil is reinforced with eight numbers of geogrid layers, each having length of 5 m and allowable tensile strength of 100 kN/m. The wall is founded on soil having allowable bearing pressure of 300 kPa. The properties of reinforced fill material and backfill is as follows:

Parameter	Reinforced fill	Backfill
Angle of internal friction	32°	30°
Unit weight	20 kN/m^3	18 kN/m^3

Check the safety of wall against overturning and bearing capacity failure.

24CE1675	REMOTE SENSING AND GIS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The general objective of this course is to make the students understand principles, processes and applications of remote sensing and GIS. The syllabus covers principles, fundamentals and application of Remote sensing and GIS, and modelling using it. Upon completing this course, students will gain the skills and knowledge necessary to effectively understand the use of geospatial data for a wide range of applications.

Prerequisite: Nil

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

CO1	Discuss different types of platforms available for remote sensing with examples. (Understand Level)
CO2	Explain the various use of remote sensing. (Understand Level)
CO3	Identify the applications of GIS. (Understand Level)
CO4	Explain the use of GIS analysis technique for modelling. (Understand Level)
CO5	Explain the application of GIS for web mapping. (Understand and Apply Level)

CO – PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	3	3	-	-	-	-	-	-	-
CO4	3	3	-	3	3	-	-	-	-	-	-	-
CO5	3	3	-	3	3	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply			✓	
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Introduction to Remote sensing)

Physics of remote sensing, interaction of earth surface features with electromagnetic radiations, atmospheric windows, effects of atmosphere, spectral signatures. Types of remote sensing, active and passive measurements, platform characteristics, satellite orbits, Sensor characteristics - spatial, temporal, spectral, radiometric resolutions,

principles of image processing, methods of encoding image data - BIL, BIP, BSQ, False Color Composite (FCC).

MODULE II (Remote sensing principles and concept)

Remote sensing energy sources and radiation principles – Electromagnetic spectrum, wave theory and particle theory, Stefan-Boltzmann law and Wein's displacement law. Interaction of Electromagnetic energy with atmosphere; Scattering - Rayleigh, Mie, and Non selective scattering; Absorption – Atmospheric transmittance and atmospheric windows. Energy interactions with earth surface features; Energy balance equation of reflection, absorption, and transmission; Specular and diffuse reflection. Multistage remote sensing concept; Satellite orbits and types of satellites – Geostationary, near polar, and sun-synchronous satellites; Satellite coverage – Satellite pass, swath width, and revisit period.

MODULE III (Introduction to GIS)

Introduction to GIS, History and development of GIS, components of GIS, Coordinate reference systems, datum and projections, map scales. Georeferencing, Spatial data concepts, data sources in GIS, data input methods, file formats for GIS standard GIS packages. Type of data, Spatial and attribute data, Data models - vector and raster, Spatial data structure - Vector data structure and raster data structure, Database management systems (DBMS), Relational database management systems (RDBMS).

MODULE IV (GIS models & modeling and Web GIS)

Basic elements in GIS modeling, binary models, index models, regression models, process model; Case studies. Model builder - Designing a data model; Cartographic modeling in GIS, GIS project management. Web mapping - Types and merits and demerits of web mapping; Elements of Web GIS, Web GIS architecture, Distributed GIS model, Map Server, Geoserver, GDAL. Web GIS development cycles, Case studies on application of web GIS in various fields.

MODULE V (Application of Remote sensing and GIS)

Application of Remote sensing - Analysis of land surface biophysical properties, land surface temperature, development of terrain models - DEM & DTM, soil type and soil moisture monitoring, vegetation indices. Remote sensing of environment – aerosol optical depth, air quality monitoring using satellite data, remote sensing of water quality, flood mapping, ocean remote sensing for oil spill detection. Application of GIS in Urban planning, agriculture, landuse/land cover changes. Application of GIS in disaster management, natural resources management, Irrigation water management. Application of GIS in Spatial and non-spatial data bank creation, mapping and navigation, site suitability analysis for infra projects, environmental science, network analysis.

Text books

1. Anji Reddy, M. Remote Sensing and Geographical Information System, BSP Publications., 2001.
2. Chang, K (2005). Introduction to Geographic Information Systems, Tata McGraw Hills Edition, New Delhi.

3. Lillesand T.M. and Kiefer R.W., Remote sensing and Image Interpretation, second Edition John Wiley and Sons, 1987.

Reference books

1. Chang K, Introduction to Geographical information system, Tata Mc-Graw-Hill,2019.
2. Floyd M. Handerson and Anthony, J. Lewis, "Principles and applications of Imaging RADAR", Manual of Remote sensing, 3rd edition, ASPRS, Jhumurley and sons, Inc, 1998.
3. Andrew, S., Environmental Modeling with GIS and Remote Sensing‖, John Willey and sons, 2002.
4. Lo, C.P & Yeung, K.W, Concepts in techniques in Geographical information system, Second Edition Pierson Prentice Hall, 2007.
5. Clarke, K.C. Parks B.O., and Crane M.P. (2006) Geographic Information systems and environmental modeling- PHI of India, New Delhi.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (5 Hours)	
1.1	Physics of remote sensing, interaction of earth surface features with electromagnetic radiations.	1
1.2	Atmospheric windows, effects of atmosphere, spectral signatures.	1
1.3	Types of remote sensing, active and passive measurements, platform characteristics, satellite orbits.	1
1.4	Sensor characteristics-spatial, temporal, spectral, radiometric resolutions.	1
1.5	Principles of image processing, methods of encoding image data-BIL, BIP, BSQ, False Color Composite (FCC).	1
	MODULE II (8 Hours)	
2.1	Remote sensing energy sources and radiation principles – Electromagnetic spectrum.	1
2.2	Wave theory and particle theory, Stefan-Boltzmann law and Wein's displacement law.	1
2.3	Interaction of Electromagnetic energy with atmosphere, Scattering – Rayleigh.	1
2.4	Mie, and Non selective scattering; Absorption - Atmospheric transmittance and atmospheric windows.	1
2.5	Energy interactions with earth surface features; Energy balance equation of reflection.	1
2.6	Absorption, and transmission; Specular and diffuse reflection.	1

2.7	Multistage remote sensing concept; Satellite orbits and types of satellites – Geostationary, near polar, and sun-synchronous satellites.	1
2.8	Satellite coverage – Satellite pass, swath width, and revisit period.	1
MODULE III (7 Hours)		
3.1	Introduction to GIS, History and development of GIS.	1
3.2	components of GIS, Coordinate reference systems, datum and projections, map scales.	1
3.3	Georeferencing, Spatial data concepts, data sources in GIS.	1
3.4	Data input methods, file formats for GIS standard GIS packages.	1
3.5	Type of data, Spatial and attribute data, Data models- vector and raster.	1
3.6	Spatial data structure - Vector data structure and raster data structure.	1
3.7	Database management systems (DBMS), Relational database management systems (RDBMS).	1
MODULE IV (8 Hours)		
4.1	Basic elements in GIS modelling, binary models, index models.	1
4.2	Regression models, process model; Case studies.	1
4.3	Model builder-Designing a data model.	1
4.4	Cartographic modelling in GIS, GIS project management.	1
4.5	Web mapping- Types and merits and demerits of web mapping.	1
4.6	Elements of Web GIS, Web GIS architecture, Distributed GIS model.	1
4.7	Map Server, Geoserver, GDAL, Web GIS development cycles.	1
4.8	Case studies on application of web GIS in various fields.	1
MODULE 5 (8 Hours)		
5.1	Application of Remote sensing - Analysis of land surface biophysical properties, land surface temperature.	1
5.2	Development of terrain models-DEM & DTM, soil type and soil moisture monitoring, vegetation indices.	1
5.3	Remote sensing of environment – aerosol optical depth, air quality monitoring using satellite data.	1
5.4	Remote sensing of water quality, flood mapping, ocean remote sensing for oil spill detection.	1

5.5	Application of GIS in Urban planning, agriculture, land use/land cover changes.	1
5.6	Application of GIS in disaster management, natural resources management, Irrigation water management.	1
5.7	Application of GIS in Spatial and non-spatial data bank creation, mapping and navigation.	1
5.8	Site suitability analysis for infra projects, environmental science, network analysis.	1

CO Assessment Questions	
CO1	Mention different types of platforms available for remote sensing with examples.
CO2	Discuss the application of remote sensing.
CO3	Differentiate vector data model and raster data model.
CO4	Explain the basic steps in GIS modelling process.
CO5	Enumerate the elements of web GIS and illustrate how a mapping web site interacts with the end user.

24CEI685	INDUSTRIAL WASTEWATER MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course focuses on imparting knowledge on the environmental legislations for the prevention and control of pollution due to industrial wastewater. The concept of zero liquid discharge is introduced and the students are exposed to the various industries through field visits and on-site learning. The course is intended to enable students to be conversant with the industrial processes, the source and characteristics of industrial wastewater and the approaches for their treatment.

Prerequisite: 24CET503 Environmental Engineering

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

CO 1	Understand industrial wastewater characteristics and their effects on the environment. (Understand Level)
CO 2	Suggest waste reduction techniques in industrial processing. (Understand Level)
CO 3	Explain industrial wastewater treatment techniques. (Understand Level)
CO 4	Appraise the wastewater generation, characteristics and treatment of major industries. (Understand Level)
CO 5	Describe strategies for industrial wastewater treatment considering the concept of ZLD. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	-	-	-	-	3	1	-	-	-	-	-
CO 2	2	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	3
CO 4	2	-	-	-	-	-	1	-	-	-	-	3
CO 5	2	-	-	-	-	3	2	-	-	-	-	1

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply			✓	
Analyse				
Evaluate				
Create				

Mark Distribution of CIA							
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Practical [P]**		**Total Marks**
		Assignment	**Test 1**	**Test -2**	**Class work**	**Lab Exam**	
3-0-0-0	5	15	10	10			**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Sources and effects of industrial wastewater)

Introduction: Sources, characteristics and effects of industrial wastewater.
Waste reduction strategies: housekeeping, volume reduction and strength reduction through source reduction, material and process modification, recycle, reuse and byproduct recovery.

MODULE II (Effluent treatment methods)

Overview of methods: Equalization - Neutralization - Floatation - Precipitation - Adsorption - Aerobic and Anaerobic Biological Treatment - Sequencing Batch Reactors – High-Rate Reactors - Chemical Oxidation - Ozonation - Photocatalysis - Wet Air Oxidation - Evaporation - Ion Exchange - Membrane Technologies.

MODULE III (Major industrial processes)

Process flow of major industrial processes: flow sheets of industries and the source of wastewater, characteristics and method of treatment of – textiles, canneries, tanneries, dairies, pharmaceuticals.

MODULE IV (Major industrial processes)

Process flow of major industrial processes: flow sheets of industries and the source of wastewater, characteristics and method of treatment of – steel industries, petroleum refineries, paper and pulp industries, electroplating industries, thermal power plants.

MODULE V (Common Effluent Treatment)

Common effluent treatment plants – location, need, processes, operation and maintenance, economic aspects, disposal of industrial waste water, environmental legislations for prevention and control of industrial effluents (brief overview only), Concept of Zero Liquid Discharge (ZLD).
Visit to major industries.

Text Books

1. M N Rao, A K Datta, Wastewater Treatment, 3rd Edition, CBS Publishers, 2018.
2. W.W. Eckenfelder, Jr., Industrial Water Pollution Control 3rd Edition, McGraw-Hill, 1999.
3. N. L. Nemerow, Industrial Waste Treatment: Contemporary Practice and Vision for the Future, Butterworth-Heinemann, 2006.

Reference books

1. Water Environment Federation (WEF), Industrial Wastewater Management, Treatment, and Disposal, 3rd Edition, WEP press, 2008.
2. Metcalf and Eddy, Inc, T. Asano, F.L. Burton, H. Leverenz, R. Tsuchihashi,G. Tchobanoglous. Water reuse Issues, Technologies and Applications McGraw-Hill 2007.
3. Manual on sewerage and sewage treatment, Central Public Health and Environmental Engineering Organization, Ministry of Urban Affairs, GoI, 2013.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (6 hours)	
1.1	Introduction, Sources of industrial wastewater.	1
1.2	Characteristics of industrial wastewater.	1
1.3	Effects of industrial wastewater.	1
1.4	Waste reduction strategies: housekeeping.	1
1.5	Volume reduction.	1

1.6	Strength reduction.	1
MODULE II (11 hours)		
2.1	Equalization.	1
2.2	Neutralization.	1
2.3	Floatation and Precipitation.	1
2.4	Adsorption.	1
2.5	Aerobic and Anaerobic Biological Treatment methods.	1
2.6	Sequencing Batch Reactors.	1
2.7	High-Rate Reactors.	1
2.8	Chemical Oxidation: Ozonation, Wet Air Oxidation.	1
2.9	Photocatalysis.	1
2.10	Evaporation, Ion Exchange.	1
2.11	Membrane Technologies.	1
MODULE III (5 hours)		
3.1	Processes, source, characteristics and treatment of textile industry.	1
3.2	Processes, source, characteristics and treatment of canneries.	1
3.3	Processes, source, characteristics and treatment of tanneries.	1
3.4	Processes, source, characteristics and treatment of dairies.	1
3.5	Processes, source, characteristics and treatment of pharmaceuticals.	1
MODULE IV (5 hours)		
4.1	Processes, source, characteristics and treatment of steel industries.	1
4.2	Processes, source, characteristics and treatment of petroleum refineries.	1

4.3	Processes, source, characteristics and treatment of paper and pulp industries.	1
4.4	Processes, source, characteristics and treatment of electroplating industries.	1
4.5	Processes, source, characteristics and treatment of thermal power plants.	1
MODULE V (9 hours)		
5.1	Common effluent treatment plants - location, need, processes.	1
5.2	Common effluent treatment plants - operation and maintenance.	1
5.3	Disposal of industrial waste water.	1
5.4	Environmental legislations.	1
5.5	Zero Liquid Discharge.	1
5.6	Field Visit report presentation.	1
5.7	Field Visit report presentation.	1
5.8	Field Visit report presentation.	1
5.9	Field Visit report presentation.	1

CO Assessment Questions	
CO1	Explain the influence of industrial wastewater on water bodies. Suggest the legislations.
CO2	Discuss the various waste reduction strategies in industries.
CO3	Describe the working principle high-rate anaerobic systems. Also mention some industries whose wastewater can be treated using such systems.
CO4	Illustrate the processes of a cannery showing the point of source generation, their characteristics and suggest the methods of treatment.
CO5	What is ZLD concept? How can you achieve it in a textile industry.

24CEI695	RAILWAY AND TUNNEL ENGINEERING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to familiarize students with the principles of Railway and Tunnel Engineering. It introduces students to railway operation and control systems, modern rail development and different tunnel construction methods. After this course students will be able to recognize different railway operation, modern developments and tunneling procedures.

Prerequisite: Nil

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

CO1	Describe the role of railways in national development (Remember Level)
CO2	Explain factors affecting railway accidents and identify the modern developments in railways. (Understand Level)
CO3	Discuss about the importance, types and methods of construction of tunnel. (Understand Level)
CO4	Identify design aspects of ventilation, lining and lighting in tunnels. (Understand Level)
CO5	Modify the geometric design of railway track by identifying component parts of railway track. (Apply Level)
CO6	Choose railway operations and control system. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-
CO 6	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Introduction to Railways in India)

Introduction to Railways in India: Role of Indian Railways in National Development – Railways for Urban Transportation - Alignment - basic requirements and factors affecting selection, Permanent Way: Typical cross-section - Component parts of a railway track - requirements and functions - Rails - Types of Rails, Rail Fastenings, Sleepers –

Functions, Materials, Density, Ballast less Tracks.
Concept of Gauges, Coning of Wheels, Creeps and kinks - Gradients - different types - Compensation of gradients, Geometric design of railway track: Horizontal curves, radius – super elevation - cant deficiency - transition curves.

MODULE II (Railway operation and control)

Points and Crossings – Design features of a turnout – Details of station yards and marshalling yards – Signalling - Classification of signals, layout of Signals, interlocking of signals and points - Principles of track circuiting – Control systems of train movements – ATC, CTC.

MODULE III (Modern developments and railway accidents)

Modern developments - LRT &MRTS, tube railways, high speed tracks. Maintenance: - Introduction to track maintenance, Items of track maintenance, packing and over hauling, screening.
Railway accidents: Human and system contribution to catastrophic accidents, Human Factors in Transport Safety.

MODULE IV (Tunnel Engineering)

Tunnel – sections – classifications - tunnel surveying - alignment, transferring center, grade into tunnel – tunnel driving procedure - shield method of tunnelling, compressed air method, tunnel boring machine.

MODULE V (Tunnel Lining and ventilation)

Tunnel lining – Necessity, materials, methods, Ventilation – natural and mechanical ventilation, drainage of tunnels, dust control methods.

Text Books

1. Mundrey J. S, Railway Track Engineering, Tata McGraw Hill, 5th edition 2017.

2. Srinivasan R., Harbour, Dock & Tunnel Engineering, Charotar Publishing House, 28e, 2016.

3. Rangawala, S.C. Railway Engineering, Charotar Publishing House 27th edition 2017.

4. Bindra, S.P., A course in Docks and Harbour Engineering, Dhanpat Rai & Sons.

Reference books

1. Chandra, S. and Agarwal, M. M., Railway Engineering, Oxford University Press, New Delhi, Second edition 2013
2. Saxena, S. C and Arora, S. P, Railway Engineering, Dhanpat Rai & Sons, 7e, 2015
3. Subhash C. Saxena, Railway Engineering, Dhanpat Rai& Sons
4. H P Oza and G H Oza, Dock and Harbour Engineering, Charotar Publishing House 8th Edition 2017

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
MODULE 1 (11 hours)		
1.1	Role of Indian Railways in National Development.	1
1.2	Railways for Urban Transportation – Alignment - basic requirements and factors affecting selection.	1
1.3	Typical cross-section.	1
1.4	Permanent Way: Components and their Functions: Component parts of a railway track – requirements and functions.	1
1.5	Rails – Types of Rails, Rail Fastenings.	1
1.6	Sleepers – Functions, Materials, Density, Ballast less Tracks.	1
1.7	Concept of Gauges, Coning of Wheels.	1
1.8	Creeps and kinks – Gradients – different types.	1
1.9	Compensation of gradients, Geometric design of railway track.	1
1.10	Horizontal curves, radius – super elevation.	1
1.11	Cant deficiency – transition curves.	1
MODULE II (8 hours)		
2.1	Points.	1
2.2	Crossings.	1
2.3	Design features of a turnout.	1
2.4	Signalling.	1
2.5	Classification of signals.	1
2.6	Layout of Signals, interlocking of signals and points.	1
2.7	Principles of track circuiting.	1
2.8	Control systems of train movements – ATC, CTC.	1
MODULE III (5 hours)		
3.1	Modern developments- LRT & MRTS.	1
3.2	Tube railways, high speed tracks.	1

3.3	Maintenance: - Introduction to track maintenance, Items of track maintenance, packing and over hauling.	1
3.4	Screening, Details of station yards and marshalling yards.	1
3.5	Railway accidents: Human and system contribution to catastrophic accidents, Human Factors in Transport Safety.	1
MODULE IV (6 Hours)		
4.1	Tunnel - sections - classification.	1
4.2	Tunnel surveying - alignment, transferring center.	1
4.3	Grade into tunnel – tunnel driving procedure.	1
4.4	Tunnelling methods - Shield method of tunneling.	1
4.5	Compressed air method.	1
4.6	Tunnel boring machine.	1
MODULE V (6 Hours)		
5.1	Tunnel lining – Necessity, materials.	1
5.2	Methods, Ventilation.	1
5.3	Natural ventilation.	1
5.4	Mechanical ventilation.	1
5.5	Drainage of tunnels, dust control methods.	1
5.6	Dust control methods.	1

CO Assessment Questions	
CO1	Describe the contribution of railways to national development.
CO2	Explain about four advanced technical remedial aids or measures for prevention of railway accidents.
CO3	Describe shield method of tunneling.
CO4	Discuss about the natural and mechanical ventilation of tunnels.
CO5	Calculate the equilibrium cant on a 2 degree curve on a BG track, if the speed of various trains are 10 trains at 50kmph., 8 trains at 55 kmph. and 4 trains at 60kmph respectively.
CO6	Calculate various leads for a B.G. turnout of crossing number 1 in 8 ½ with heel divergence as 114.30 mm.

MINOR & HONOURS COURSES

24CEM609	GEOTECHNICAL INVESTIGATION AND GROUND IMPROVEMENT TECHNIQUES	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: The objective of this course is to equip students with the knowledge of site investigation programme and the various ground improvement techniques to deal with problematic soils. This course covers the commonly adopted site investigation methods, various sampling techniques, design aspects and procedures of various ground improvement techniques. This course will enhance the capability of students to make sound engineering judgments related to the field based on detailed analysis to recommend the appropriate methods for the smooth conduct of site investigation programme and suggest suitable ground improvement method.

Prerequisite: Nil

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

CO1	Apply suitable techniques for subsoil exploration. (Apply Level)
CO2	Interpret the test results from site investigation tests. (Understand and Apply Level)
CO3	Classify different ground improvement methods based on the soil suitability. (Understand Level)
CO4	Outline the basic concept/ design aspects of various ground improvement methods. (Understand Level)
CO5	Explain the construction procedure of different ground improvement methods. (Understand Level)

CO – PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-
CO5	2	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember				
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyze				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hrs

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question, 2 questions from each module, each carries 3 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (8×5 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Site Investigation Programme and Penetration Test)

Site investigation and soil exploration: Introduction and practical importance. Sampling - Different types of samplers - Sampling below water table - Core Recovery and Rock Quality Designation. Numericals. Sounding and Penetration Tests - Standard Penetration Test – Procedure - Boring log - soil profile- Location of Water table - Corrections to be applied to observed N values – Numerical examples - Correlations of N

value with various engineering and index properties of soils. Classification of soil based on N value.

MODULE II (Sounding Methods and Non-Destructive Tests)

Static Cone Penetration Test (SCPT) and Dynamic Cone Penetration Test (DCPT) – Procedure - Numericals on cone penetration tests. Geophysical methods: Seismic Refraction method and Electrical Resistivity method – Wenner method and Schlumberger method - Procedure - Numerical on geophysical methods. Comparison of various penetration tests and geophysical methods. Pressuremeter test and Flat Dilatometer test. (brief)

MODULE III (Ground Improvement by Compaction Techniques)

Ground Improvement Techniques: Introduction – Objectives - Suitability and feasibility. Emerging trends in ground improvement. Mechanical Modification: Shallow and Deep Compaction - Shallow compaction – Rollers - Deep Compaction - Dynamic compaction - Compaction piles - Blasting technique - Vibro compaction – Vibroflotation - Terra probe method - Vibro replacement.

MODULE IV (Physical, Chemical and Sustainable Methods)

Physical and Chemical Modification: Grouting – materials - Grouting systems: One shot and two shot systems - Modes of grouting - Main types of grouting: Permeation Grouting, Compaction Grouting and Jet Grouting – Practical Applications - Grouting Plant and equipment - Grouted columns – Curtain and blanket grouting – Practical applications - Lime stabilization – Mechanism - optimum lime content - lime fixation point. Introduction to sustainable methods of soil stabilization - Biopolymer, Calcite precipitation: Mechanism of improvement.

MODULE V (Drainage Systems)

Hydraulic modification: Open sumps and ditches, Wellpoint systems, deep well drainage, Vacuum dewatering, Electro osmosis. Sand piles and Stone columns (design concepts only) - Preloading techniques – Sand drains. Design of dewatering for excavations.

Text books

1. P. Purushothama Raj, Ground Improvement Techniques, Laxmi Publications (P) Ltd.
2. Manfred. R. Hausmann, Engineering Principles of Ground Modification, McGraw Hill, 1989.

Reference books

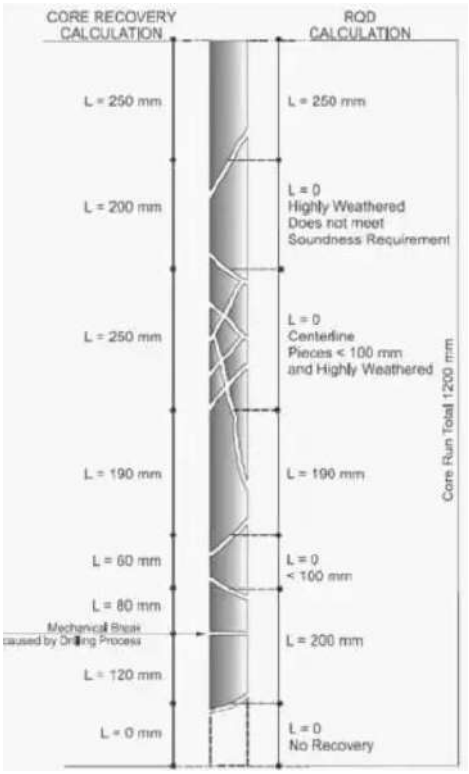
1. M.P. Moseley and K. Kirsch (Edited), Ground improvement, Second edition, Spon Press, Taylor and Francis.
2. James K. Mitchell, Kenichi Soga, Fundamentals of Soil Behaviour, Wiley and Sons Inc.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (45)
MODULE I (9 Hours)		
1.1	Site investigation and soil exploration: Introduction and practical importance.	1
1.2	Sampling - Different types of samplers.	1
1.3	Sampling below water table.	1
1.4	Core Recovery and Rock Quality Designation. Numericals.	1
1.5	Sounding and Penetration Tests - Standard Penetration Test – Procedure.	1
1.6	Boring log - soil profile - Location of Water table.	1
1.7	Corrections to be applied to observed N values – Numerical examples.	1
1.8	Corrections to be applied to observed N values – Numerical examples.	1
1.9	Correlations of N value with various engineering and index properties of soils. Classification of soil based on N value.	1
MODULE II (9 Hours)		
2.1	Static Cone Penetration Test (SCPT) - Procedure - Numericals on cone penetration tests.	1
2.2	Dynamic Cone Penetration Test (DCPT) – Numericals on cone penetration tests.	1
2.3	Geophysical methods: Seismic Refraction method.	1
2.4	Geophysical methods: Seismic Refraction method.	1
2.5	Electrical Resistivity method – Wenner method and Schlumberger method - Procedure.	1
2.6	Numerical on geophysical methods.	1
2.7	Comparison of various penetration tests and geophysical methods.	1
2.8	Pressuremeter test (brief).	1
2.9	Flat Dilatometer test (brief).	1
MODULE III (9 Hours)		
3.1	Ground Improvement Techniques: Introduction – Objectives.	1
3.2	Suitability and feasibility.	1

3.3	Emerging trends in ground improvement.	1
3.4	Mechanical Modification: Shallow and Deep Compaction - Shallow compaction – Rollers.	1
3.5	Deep Compaction - Dynamic compaction.	1
3.6	Compaction piles.	1
3.7	Blasting technique.	1
3.8	Vibro compaction, Vibroflotation.	1
3.9	Terra probe method, Vibro replacement.	1
MODULE IV (9 Hours)		
4.1	Physical and Chemical Modification: Grouting – materials.	1
4.2	Grouting systems: One shot and two shot systems.	1
4.3	Modes of grouting.	1
4.4	Main types of grouting: Permeation Grouting.	1
4.5	Compaction Grouting and Jet Grouting.	1
4.6	Practical Applications - Grouting Plant and equipment.	1
4.7	Grouted columns – Curtain and blanket grouting.	1
4.8	Lime stabilization –Mechanism-optimum lime content-lime fixation point.	1
4.9	Introduction to sustainable methods of soil stabilization-Biopolymer, Calcite precipitation: Mechanism of improvement.	1
MODULE V (9 Hours)		
5.1	Hydraulic modification: Open sumps and ditches.	1
5.2	Hydraulic modification: Open sumps and ditches.	1
5.3	Wellpoint systems.	1
5.4	Deep well drainage.	1
5.5	Vacuum dewatering, Electro osmosis.	1
5.6	Sand piles (design concepts only).	1

5.7	Stone columns (design concepts only).	1
5.8	Preloading techniques – Sand drains.	1
5.9	Design of dewatering for excavations.	1

CO Assessment Questions	
CO1	1. Mention the technique that can be employed for determining the stratification of soil using a non-destructive technique. 2. Describe the procedure to be adopted for detailed site investigation.
CO2	1. Determine the rock quality index and core recovery for the rock sample recovered from site.  2. One sampler has an area ratio of 8% while another has 16%; which of these samplers do you prefer and why?
CO3	1. Describe the method of compaction employed for cohesionless deposits. 2. Mention the various classifications of ground improvement methods.
CO4	3. Outline the design aspects of dynamic compaction. 4. Explain the considerations for the implementation of permeation grouting.
CO5	1. Describe the experimental setup of electroosmosis. 2. Explain the procedure of the blasting technique.

24CEH619	FUNCTIONAL DESIGN OF BUILDINGS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: The course intends to impart knowledge on the principles of acoustics, lighting, and thermal comfort in buildings. The course provides information on the various aspects of functional elements and the protection of buildings against fire, as well as the principles of Vastusastra. The course enables the students to be conversant on the various aspects of functional design of buildings and innovative construction methods.

Prerequisite: 23CET407 Construction Technology

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

CO1	Describe acoustical design and noise control techniques. (Understand and Apply level)
CO2	Explain elemental concepts of natural and artificial lighting designs. (Understand level)
CO3	Explain the principles involved in the design of buildings for thermal comfort and shading devices. (Apply level)
CO4	Illustrate the basic concept for electrical load calculation, functioning of elevators and escalators and rough cost estimation. (Understand and Apply level)
CO5	Explain the relevance of vastusastra and identify the innovative construction concepts. (Understand level)

CO – PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	3	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyze				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	40

Total Mark distribution

Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hrs

End Semester Examination [ESE]: Pattern

Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question, 2 questions from each module, each carries 3 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (8×5 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Acoustical / Sonic Environment and Acoustical Comfort)

Sound, Nature of sound - Behavior of sound in enclosed spaces - Concept of Geometric Acoustics - Reflection of sound and their applications - Absorption of sound - Sound absorption coefficient - Human Audibility range - Reverberation & Reverberation Time Calculation - Sabine's formula - Sound absorption - materials - Basic design of the elements for the required degree of sound insulation - Air and structure born noises - Measures of noise control - Acoustical defects - acoustical design of auditoriums and

small lecture halls - Acoustical considerations of offices, hospitals and Industrial buildings.

MODULE II (Lighting)

Natural lighting: Visual task requirements, Units of Light, Light, Vision and Buildings, Standards of Lighting and Visual comfort - The sky as a source of light, Daylight factor, Daylight penetration - Calculation of daylight factor. Design of side-lit windows - BIS and CBRI methods – skylights.

Artificial lighting: Artificial lighting - illumination requirements - lux meter – lamps and luminaries – polar distribution curves – Color temperature and color rendering index - glare - Design of artificial lighting – lumen method – point by point method. Basic idea of street lighting and outside lighting. Permanent Supplementary Artificial Lighting of Interiors (PSALI).

MODULE III (Thermal Design of Buildings)

Thermal comfort: Factors affecting thermal comfort - thermal comfort indices – ET - CET - Bioclimatic chart - Psychrometry and Psychrometric chart (Brief description only). As per ISO – Fanger's Theory – Predicted Mean Vote (PMV), Predicted percentage of Dissatisfied (PPD). Analysis.

Earth-Sun relationship: Sun's apparent movement with respect to the earth. Solar angles - Computation of solar radiation on different surfaces - solar path diagram - shadow - throw concept and design of shading devices.

Design approaches - Climate conscious designs - Climatic zones in India - orientation and shape of buildings in different climatic zones - Passive solar - Active solar and Active approaches. Requirements of buildings in tropical areas - Thermal insulation.

MODULE IV (Functional Elements and Protection)

Functional elements: Design Concept for electrical installation of residential building – Basic concept of functioning of elevators and escalators - basic cost estimation. Functional protection: Causes of fire, Mechanism of fire spread in buildings, classification of fire - High temperature effects and combustibility of building materials and structure - Fire alarm system, and means of escape - Firefighting installations.

MODULE V (Functionality Concepts)

Relevance of Vastusastra in modern architecture - functionality aspects related to planning and energy pattern of residential building - different perspectives on the functional design of buildings - understand traditional techniques in Tropical climate with vernacular buildings in Kerala as case study. Innovative concepts of functionality: Concept of green building - case studies on low energy and green buildings - Concepts of Intelligent building - Thirsty concrete - Blue roads - self healing concrete.

Text books

1. Knudsen V.O. and Harris C.M., Acoustical Design in Architecture, John Wiley, 1980.
2. Marshall Long, "Architectural Acoustics", Second Edition, Academic Press, Waltham, USA, 2014.
3. Pritchard, D.C., "Lighting", Longman Scientific & Technical, Harlow,1995.

4. Benjamin Evans, "Daylight in Architecture", McGraw - Hill Book Company, Newyork,1981.
5. Koenigseberger, Manual of tropical Housing and Building Part I – Climatic design, Orient Longman, 2011.
6. Ajitha Simha D., Building Environment, Tata McGraw Hill Publishing Co., New Delhi,1985.
7. Jain. V.K., "Design and Installation of Services in Building complexes & High Rise Buildings", Khanna Tech. Publishers, New Delhi,1986.
1. Wayne Forster and Dean Hawkes, “Energy Efficient Buildings: Architecture, Engineering, and Environment”. W.W. Norton Company Inc. 2002.

Reference books

1. M David Egan, Architectural Acoustics, J. Ross Publishing, 2007.
2. Bureau of Indian standards, Handbook on Functional Requirement of Buildings – SP:41(S and T)-1987.
3. National Building Code of India (NBC2016).
4. Bureau of Energy Efficiency, India. Design Guidelines for Energy Efficient Multi-Storey Buildings,2014.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (48)
	MODULE I (11 Hours)	
1.1	Acoustical / Sonic Environment and acoustical comfort: Sound, Nature of sound.	1
1.2	Behavior of sound in enclosed spaces.	1
1.3	Concept of Geometric Acoustics - Reflection of sound and their applications.	1
1.4	Absorption of sound - Sound absorption coefficient.	1
1.5	Human Audibility range - Reverberation & Reverberation Time Calculation - Sabine’s formula.	1
1.6	Sound absorption – materials.	1
1.7	Basic design of the elements for the required degree of sound insulation - Air and structure born noises.	1
1.8	Measures of noise control and acoustical defects.	1
1.9	Acoustical design of auditoriums.	1
1.10	Acoustical design of small lecture halls.	1
1.11	Acoustical considerations of offices, hospitals and Industrial buildings.	1
	MODULE II (8 Hours)	
2.1	Natural lighting: Visual task requirements, Units of Light, Light, Vision and Buildings.	1

2.2	Standards of Lighting and Visual comfort - The sky as a source of light, Daylight factor.	1
2.3	Daylight penetration - Calculation of daylight factor.	1
2.4	Design of side-lit windows - BIS and CBRI methods – skylights.	1
2.5	Artificial lighting - illumination requirements - lux meter – lamps and luminaries – polar distribution curves.	1
2.6	Color temperature and color rendering index - glare.	1
2.7	Design of artificial lighting – lumen method – point by point method.	1
2.8	Basic idea of street lighting and outside lighting - Permanent Supplementary Artificial Lighting of Interiors (PSALI).	1
MODULE III (11 Hours)		
3.1	Thermal comfort: Factors affecting thermal comfort - effective temperature.	1
3.2	Thermal comfort indices – ET - CET Charts - Bioclimatic chart - Psychrometry and Psychrometric chart.	1
3.3	Earth-Sun relationship: Sun's apparent movement with respect to the earth. Solar angles.	1
3.4	Computation of solar radiation on different surfaces - solar path diagram – shadow - throw concept.	1
3.5	Computation of solar radiation on different surfaces - solar path diagram – shadow - throw concept.	1
3.6	Design of shading devices.	1
3.7	Design of shading devices.	1
3.8	Design approaches: Climate conscious designs.	1
3.9	Climatic zones in India - orientation and shape of buildings in different climatic zones.	1
3.10	Passive solar - Active solar and Active approaches.	1
3.11	Requirements of buildings in tropical areas - Thermal insulation.	1
MODULE IV (9 Hours)		
4.1	Functional elements: Design Concept for electrical installation of residential building.	1
4.2	Design Concept for electrical installation of residential building.	1
4.3	Basic concept of functioning of elevators and escalators - estimation.	1

4.4	Basic cost estimation of services.	1
4.5	Functional protection: Causes of fire, Mechanism of fire spread in buildings.	1
4.6	Classification of fire - High temperature effects and combustibility of building materials and structures.	1
4.7	Classification of fire - High temperature effects and combustibility of building materials and structures.	1
4.8	Fire alarm system, and means of escape.	1
4.9	Firefighting installations.	1
MODULE V (9 Hours)		
5.1	Functionality as per Vastusastra: Basic concepts.	1
5.2	Governing criteria of functionality - Energy pattern.	1
5.3	Different perspectives on the functional design of buildings.	1
5.4	Understand traditional techniques in Tropical climate.	1
5.5	Understand traditional techniques in Tropical climate with vernacular buildings in Kerala as case study.	1
5.6	Innovative concepts of functionality: Concept of green building.	1
5.7	Case studies on low energy and green buildings.	1
5.8	Concepts of Intelligent building - Thirsty concrete.	1
5.9	Blue roads - self healing concrete.	1

CO Assessment Questions	
CO1	1. Develop an understanding of acoustical design and noise control techniques. 2. Explain the applications of acoustics. 3. Explain the acoustical considerations for offices, hospitals and industrial buildings.
CO2	1. Explain the purposes of lighting. 2. Explain the basic concepts of natural and artificial lighting. 3. Explain the different methods used for the design of natural lighting. 4. Explain the different methods used for the design of artificial lighting.

CO3	1. Evaluate the principles involved in the design of buildings for thermal comfort. 2. Explain sun path diagram.
CO4	1. Describe the basic concepts for electrical load calculation of structures. 2. Explain the functioning of elevators and escalators. 3. Explain rough cost estimation.
CO5	1. Explain traditional techniques in Tropical climate with vernacular buildings in Kerala. 2. Explain the concepts of green building. 3. Describe concepts for intelligent buildings. 4. Explain innovative construction methods.

24CEH629	EARTH DAM AND EARTH RETAINING STRUCTURES	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: The primary objective of this course is to provide students with a profound understanding of the fundamentals related to earth dams and earth pressure theories. The curriculum is designed to be comprehensive, encompassing an in-depth study of slope stability analysis and the design principles of retaining structures. At the end of the course, students will be able to calculate earth pressure theories, analyze slope stability of earth dam and the design of retaining walls.

Prerequisite: 24CEJ502 Foundation Engineering

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

CO1	Explain the fundamentals of earth dams. (Understand Level)
CO2	Analyze slope stability of earth dams. (Apply Level)
CO3	Explain the basic concepts & theories of Earth pressure. (Understand Level)
CO4	Design Rigid and Flexible Retaining Walls applying the earth pressure theories. (Apply Level)
CO5	Calculate earth pressure for different types of retaining structures. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	3	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	2	3	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyze				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question, 2 questions from each module, each carries 3 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (8×5 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Introduction to Earth dams)

Earth dams – types of dams - Selection of type of dam based on material availability - Foundation conditions and topography - Design details – crest, free board, upstream and downstream slopes, upstream and downstream slope

protection – central and inclined cores - Types and design of filters (Design criteria only) - Seepage analysis and control – seepage through dam and foundations – control of seepage in earth dam and foundation.
MODULE II (Construction techniques & Quality control of earth dam)
Construction techniques of earth dams – methods of construction - Quality control Instrumentation – measurement of pore pressures - Determination of phreatic line - Stability analysis – critical stability conditions - Desired values of factor of safety for different loading conditions of dam - Evaluation of stability by Swedish Slip Circle Method and sliding wedge method under critical conditions.
MODULE III (Earth Pressure Theories and Computation Methods)
Earth pressure theories – Rankine's and Coulomb's earth pressure theories for cohesionless and cohesive backfills – Computation of earth pressures for various cases – inclined – with surcharge – submerged and partly submerged – stratified backfills - Rigid retaining structures – active and passive earth pressures against gravity retaining walls – Numerical Problems - Computation of earth pressures by Trial wedge method – A mathematical approach for completely submerged and partly submerged backfills - Numerical Problems - Importance of capillary tension in earth pressure.
MODULE IV (Graphical Methods and Design of Retaining Walls)
Graphical methods of earth pressure computation – trial wedge method for Coulomb‘s and Rankine's conditions, for regular and irregular ground and wall conditions -Rebhann's construction for active pressure - Friction circle method - Logarithmic spiral method - Design of gravity retaining wall – cantilever retaining walls - Numerical Problems - Flexible retaining structure – type and methods of construction – design strength parameters.
MODULE V (Safety and Design Considerations for Sheet Pile Walls, Diaphragm Walls, and Cofferdams)
Safety factor for sheet pile walls – Computation of earth pressures against cantilever sheet piles in cohesionless and cohesive soils – Numerical Problems - Anchored sheet piles – free earth method – fixed earth method – Rowe ‘s moment reduction method - Stability of sheet piling - Diaphragm walls and coffer dams – types of diaphragm walls and their construction techniques in various soil types - Earth pressure on braced cuts and cofferdams – Design of cofferdams. (Concepts only)
Text books 1. Tschebotarioff G P, Foundations, Retaining and earth structures, 2nd edition, McGraw Hill Pub., 1973.
Reference books 1. Clayton, Milititsky and Woods, Earth Pressure and Earth-Retaining Structures, Taylor and Francis, 1996. 2. Huntington, Earth pressure on retaining walls, John Wiley and Sons, 1957. 3. Prakash, Ranjan and Saran, Analysis and Design of Foundations and

Retaining structures, Saritha Prakashan, Meerut, 1977.
4. Bowles, Foundation Analysis and Design, 1968.
5. Jones, Earth Reinforcements and Soil structures, 1996.
6. IS: 7894 – 1975, Indian Standard Code of Practice for Stability Analysis of Earth Dams.

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours (45)
	MODULE I (9 hours)	
1.1	Earth dams – types of dams.	1
1.2	Selection of type of dam based on material availability.	1
1.3	Foundation conditions and topography.	1
1.4	Design details – crest, free board, upstream and downstream slopes.	1
1.5	Upstream and downstream slope protection – central and inclined cores.	1
1.6	Types of filters.	1
1.7	Design of filters. (Design criteria only)	1
1.8	Seepage analysis and control – seepage through dam and foundations.	1
1.9	Control of seepage in earth dam and foundation.	1
	MODULE II (9 hours)	
2.1	Construction techniques of earth dams – methods of construction.	1
2.2	Quality control Instrumentation – measurement of pore pressures.	1
2.3	Determination of phreatic line.	1
2.4	Stability analysis – critical stability conditions.	1
2.5	Stability analysis – critical stability conditions.	1
2.6	Desired values of factor of safety for different loading conditions of dam.	1
2.7	Evaluation of stability by Swedish Slip Circle Method critical condition.	1
2.8	Evaluation of stability sliding wedge method under critical condition.	1

2.9	Numerical problems on slope stability of earth dams.	1
MODULE III (9 hours)		
3.1	Earth pressure theories – Rankine 's and Coulomb's earth pressure theories for cohesionless and cohesive backfills.	1
3.2	Computation of earth pressures for various cases – inclined – with surcharge – submerged.	1
3.3	Computation of earth pressures for various cases – partly submerged – stratified backfills.	1
3.4	Rigid retaining structures – active and passive earth pressures against gravity retaining walls.	1
3.5	Numerical Problems on computation of earth pressure for various cases.	1
3.6	Computation of earth pressures by Trial wedge method – A mathematical approach for completely submerged.	1
3.7	Computation of earth pressures by Trial wedge method – partly submerged backfills.	1
3.8	Numerical Problems on Computation of earth pressures by Trial wedge method.	1
3.9	Importance of capillary tension in earth pressure.	1
MODULE IV (9 hours)		
4.1	Graphical methods of earth pressure computation – trial wedge method for Coulomb 's and Rankine 's conditions, for regular ground and wall conditions.	1
4.2	Graphical methods of earth pressure computation – trial wedge method for Coulomb 's and Rankine 's conditions for irregular ground and wall conditions -Rebhann 's construction for active pressure.	1
4.3	Friction circle method - Logarithmic spiral method.	1
4.4	Design of gravity retaining wall.	1
4.5	Design of gravity retaining wall.	1
4.6	Design of cantilever retaining walls.	1
4.7	Design of cantilever retaining walls.	1
4.8	Numerical Problems.	1
4.9	Flexible retaining structure – type and methods of construction – design strength parameters.	1

MODULE V (9 hours)		
5.1	Safety factor for sheet pile walls – Computation of earth pressures against cantilever sheet piles in cohesionless and cohesive soils.	1
5.2	Numerical Problems.	1
5.3	Anchored sheet piles – free earth method – fixed earth method.	1
5.4	Rowe 's moment reduction method.	1
5.5	Stability of sheet piling.	1
5.6	Diaphragm walls- types and their construction techniques in various soil types.	1
5.7	Earth pressure on braced cuts.	1
5.8	Earth pressure on coffer dams.	1
5.9	Design of coffer dams. (Concept only)	1

CO Assessment Questions	
CO1	1. Explain the types of dams. 2. Explain about the seepage through Dam and foundation. 3. Discuss in detail the Terzaghi's criteria for the filter design. 4. Explain the control of seepage in earth dam.
CO2	1. Explain the instrumentation for quality control of dams. 2. Discuss the different construction techniques of an earth dam. 3. Explain Swedish Slip Circle method of stability analysis. 4. Explain Sliding Wedge method of stability analysis. 5. An earth dam has a height of 30 meters and a slope inclination of 1:2 (H: V). The cohesive soil has an internal friction angle of 30 degrees. The water level behind the dam is at a height of 25 meters. The unit weight of the soil is 18 kN/m^3, and the unit weight of water is 10 kN/m^3. Using the Swedish Slip Circle method, determine the factor of safety against slope failure for the given conditions.
CO3	1. List the assumptions of Coulomb's theory of earth pressure. 2. Explain Trial wedge method of earth pressure. 3. Compute the total lateral earth thrust exerted by a layered backfill of height 10m if the wall has a tendency to move away from the backfill. The upper layer

	of thickness 4 m has angle of internal friction 32° and unit weight 19 kN/m^3. The lower layer has angle of internal friction 28°, cohesion 20kPa, and unit weight 18 kN/m^3. The backfill also supports a uniform surcharge of intensity 10kN/m^2. Also find the point of application. 4. Explain the importance of capillary tension in computation of earth pressure
CO4	1. Differentiate between rigid and flexible retaining structures. 2. Explain the methods of construction of flexible retaining structures. 3. Explain design strength parameters of a flexible retaining wall. 4. The retaining wall, which stands at a height of 6 meters, features a back inclined at a positive batter angle of 15 degrees. The ground surface, inclined upward at an angle of 20 degrees, retains a backfill with following properties: γ= 19kN/m^3, φ = 34°, δ = 20°. (i) Determine the total active thrust by Rebann's graphical construction. (ii) A surcharge of 50kN/m^2 is acting on the backfill. What is the magnitude of total active thrust?
CO5	1. Discuss the different types of cofferdams. 2. An anchored sheet pile is to support a mass of cohesion less soil up to height of 6m above ground level with horizontal anchor toes spaced at 1m intervals and located at 1.0m below the ground surface. If the unit weight of the soil is 21kN/m^3 and its angle of internal friction is 30°, determine the minimum depth of embedment of the sheet pile for stability. 3. Explain the step-by-step procedure for design of a diaphragm wall. 4. Describe the stability checking of sheet pile wall using fixed and free earth support methods.

24CEH639	ENVIRONMENTAL POLLUTION AND CONTROL TECHNIQUES	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: The course is designed to impart knowledge on the fundamental aspects of environmental pollution and its control techniques among students. It helps the learners to understand the sources of environmental pollution, characteristics of pollutants and waste treatment techniques. Students will be able to adopt appropriate strategies to control environmental pollution.

Prerequisite: 23CET503 Environmental Engineering

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

CO1	Explain the environmental monitoring strategies. (Understand Level)
CO2	Describe the sources, effects and control techniques of air pollution. (Understand Level)
CO3	Describe the sources, effects and control techniques of water pollution. (Understand Level)
CO4	Describe the sources, effects and control techniques of land and noise pollution. (Understand Level)
CO5	Explain the environmental legislation and policies. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	2	2	-	-	-	-	-
CO 2	3	-	-	-	-	2	2	-	-	-	-	-
CO 3	3	-	-	-	-	2	2	-	-	-	-	-
CO 4	3	-	-	-	-	2	2	-	-	-	-	-
CO 5	3	-	-	-	-	2	2	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution

Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Environmental monitoring)

Introduction: Link between source/environment/receptor; Exposure; Health effects; Toxicology; Defining the need for fate and transport. Monitoring of environmental parameters – screening parameters, sampling techniques and analytical methods to measure environmental contamination in air, water and soils.

MODULE II (Air pollution and control)

Air pollution – Sources – Types of pollutants - Criteria pollutants, Control of gaseous pollutants (adsorption, absorption, reaction and other methods) – Control of particulate pollutants (settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators, Industrial pollution control, Air Pollution Mitigation Measures - Ambient air quality standards.

MODULE III (Water pollution and control)

Sources – Types of Pollutants – Effects - Treatment and control methods – Physio-chemical and Biological Treatments – Screening, skimming, sedimentation, coagulation, Filtration, Trickling Filters, Activated sludge process, Oxidation ponds, Characteristics of industrial wastes: physical, chemical and biological. Pretreatment of industrial wastes: waste volume reduction, waste strength reduction neutralization, equalization and proportioning. High-rate anaerobic methods (design not needed). Control of pharmaceuticals, dioxins, pesticides, microplastics, Poly Cyclic Aromatic Hydrocarbons.

MODULE IV (Land and noise pollution)

Type and source of solid waste, characteristics, collection, segregation, transportation and processing- Waste minimization strategies – Reduction - Recycling – Reuse; Disposal - composting, sanitary landfill, incineration; Hazardous Waste Treatment and Disposal - Biological and chemical treatment of hazardous wastes, Landfill disposal of hazardous waste; Bioremediation of hazardous waste disposal sites.

Noise pollution: Noise units, sources, Effects of noise pollution, Control of noise pollution.

MODULE V (Legislation and Policies)

Important Environmental rules and regulations, environmental protection acts and rules. Environmental Management Plan, identification and mitigation of environmental impacts. Essential elements of an Environmental Management System (EMS)

Text Books

1. Peavy, Rowe, Tchobanoglous, Environmental Engineering, Mc Graw Hill International Editions.
2. M.N. Rao & H.V.N. Rao, Air Pollution, Tata Mc Graw Hill Pvt. Ltd., New Delhi.
3. S. K. Garg, Environmental Engineering Vol. l & ll, Khanna Publishers, New Delhi.
4. B.C. Punmia, Waste water Engineering, Arihant Publications, Jodpur.
5. C.S. Rao, Environmental Pollution Control Engineering, New Age International (P) Ltd, New Delhi.

Reference books

1. Nelson Leonard Nemerow, Theories and practices of industrial waste treatment, Addison Wesley Publishing Co., Inc.
2. Wesley Eckenfelder Jr., Industrial water pollution control, International Edition, Mc Graw Hill Inc, New Delhi.

3. M Narayana Rao, Waste water treatment, Rational methods of design and Industrial practice, Oxford & IBH Publishing Co. Pvt. Ltd, Bombay.
4. Warren Viessman and mark J Hammer, Water Supply and Pollution Control, Pearson Education, Inc.
5. Gilbert M. Masters, Kurian Joseph and R. Nagendran, Introduction to Environmental Engineering and Science.
6. Ruth F. Weiner and Robin Matthews, Environmental Engineering, Butterworth-Heinemann, Elsevier.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (45)
	MODULE 1 (10 hours)	
1.1	Introduction: Link between source/environment/receptor.	1
1.2	Exposure and Health effects.	1
1.3	Toxicology.	1
1.4	Defining the need for fate and transport.	1
1.5	Monitoring of environmental parameters – screening parameters.	1
1.6	Sampling techniques to measure environmental contamination in air.	1
1.7	Sampling techniques to measure environmental contamination in water.	1
1.8	Sampling techniques to measure environmental contamination in soils.	1
1.9	Analytical methods to measure environmental contamination in air, water and soils.	1
1.10	Analytical methods to measure environmental contamination in air, water and soils.	1
	MODULE II (10 hours)	
2.1	Air pollution – Sources – Types of pollutants.	1
2.2	Criteria pollutants.	1
2.3	Control of gaseous pollutants. (adsorption, absorption)	1
2.4	Control of gaseous pollutants. (reaction and other methods)	1
2.5	Control of particulate pollutants. (settling chambers, cyclone separation)	1

2.6	Control of particulate pollutants. (Wet collectors, fabric filters)	1
2.7	Control of particulate pollutants. (electrostatic precipitators)	1
2.8	Industrial pollution control.	1
2.9	Air Pollution Mitigation Measures.	1
2.10	Ambient air quality standards.	1
MODULE III (10 hours)		
3.1	Sources – Types of Pollutants – Effects.	1
3.2	Treatment and control methods – Physico-chemical methods - Screening, skimming, sedimentation, coagulation, Filtration.	1
3.3	Treatment and control methods – Physico-chemical methods - Screening, skimming, sedimentation, coagulation, Filtration.	1
3.4	Treatment and control methods – Biological methods- Trickling Filters, Activated sludge process, Oxidation ponds.	1
3.5	Characteristics of industrial wastes: physical, chemical and biological.	1
3.6	Pretreatment of industrial wastes: waste volume reduction, waste strength reduction.	1
3.7	Neutralization, equalization and proportioning.	1
3.8	High rate anaerobic methods. (design not needed)	1
3.9	Control of pharmaceuticals, dioxins, pesticides, microplastics.	1
3.10	Poly Cyclic Aromatic Hydrocarbons.	1
MODULE IV (9 Hours)		
4.1	Type and source of solid waste, characteristics, collection.	1
4.2	Segregation, transportation and processing.	1
4.3	Waste minimization strategies – Reduction – Recycling – Reuse.	1
4.4	Disposal - composting, sanitary landfill, incineration.	1
4.5	Hazardous Waste Treatment and Disposal – Biological and chemical treatment of hazardous wastes.	1
4.6	Landfill disposal of hazardous waste.	1
4.7	Bioremediation of hazardous waste disposal sites.	1
4.8	Noise pollution: Noise units, sources.	1
4.9	Effects of noise pollution, Control of noise pollution.	1
MODULE V (6 Hours)		
5.1	Important Environmental rules and regulations.	1

5.2	Environmental protection acts and rules.	1
5.3	Environmental Management Plan.	1
5.4	Environmental Management Plan.	1
5.5	Identification and mitigation of environmental impacts.	1
5.6	Essential elements of an Environmental Management System. (EMS)	1

CO Assessment Questions	
CO1	Discuss the sampling techniques for measurement of contamination in soil.
CO2	Discuss the control technologies for gaseous pollutants.
CO3	Explain with a neat sketch, the working of an activated sludge process. State the merits and demerits of the process as well.
CO4	How do the waste matters are stabilized during Sanitary Land Filling? Explain.
CO5	Enumerate the different environmental rules and regulations in India.

Semester 7

B.Tech (Civil Engineering) Curriculum – Semester 7

SEVENTH SEMESTER												Total Marks	
Sl No	Slot	Code	Category	Title	L	T	P	J	S	Hours	Credits	CIA	ESE
1	A	24CEP701	PCC	Construction Project Management (Internship Students: Online Classes with virtual lab)	3	0	2	0	5	5	4	60	40
2	B	24HUT702	HSMC	Finance and Accounting for Engineers (Internship Students: Online Classes with virtual lab	2	1	0	0	2	3	3	40	60
3	C	24CEE7X3	PEC	Professional Elective-3 (Internship Students: MOOC Approved by the Institute/Online Classes)	3	0	0	0	3	3	3	40	60
4	D	24CEO7X4/ 24CEI7X4	OEC /IEC	Open Elective 1/ Industry Elective (Internship Students: MOOC Approved by the Institute/Online Classes)	3	0	0	0	3	3	3	40	60
5	U	24CED705	PR	Major Project	0	0	14	0	14	14	7	100	
6	L	24CEL706	PCC	Design Studio	0	0	2	0	2	2	1	50	
7	M / H / R	24CEM709 /24CEH709	PRM/ HR	PROJECT IN MINOR/HONOURS / REMEDIAL	0	0	0	4			4/4 /0	100	
TOTAL									**29**	**29**	**21**		

Semester VII	PROFESSIONAL ELECTIVE III	Micro Specialisation
CEE713	STRUCTURAL DYNAMICS AND EARTHQUAKE RESISTANT DESIGN	Gr-I
CEE723	ADVANCED STRUCTURAL ANALYSIS	Gr-I
CEE733	BUILDING SERVICES	Gr-II
CEE743	REPAIR AND REHABILITATION OF BUILDINGS	Gr-II
CEE753	ADVANCED FOUNDATION ENGINEERING	Gr-III
CEE763	INTEGRATED WASTE MANAGEMENT	Gr-III
CEE773	APPLIED HYDROLOGY	Gr-IV
CEE783	DESIGN OF HYDRAULIC STRUCTURES	Gr-IV
CEE793	ADVANCED ENVIRONMENTAL ENGINEERING	Gr-V
CEE7103	TRANSPORTATION PLANNING	Gr-VI
CEE7113	OPTIMISATION TECHNIQUES IN CIVIL ENGINEERING	-

Semester VII **OPEN ELECTIVE I**

24CEI714	ENVIRONMENTAL IMPACT ASSESSMENT
24CEI724	ROAD SAFETY AND MANAGEMENT
24CEI734	PROJECT MANAGEMENT

Honours and Minor Courses

Minor in Civil Engineering

24CEM709	MINI PROJECT

HONOURS					
BASKET 1		**BASKET 2**		**BASKET 3**	
STRUCTURAL ENGINEERING AND CONSTRUCTION MANAGEMENT		**TRANSPORTATION AND GEOTECHNICAL ENGINEERING**		**WATER RESOURCES AND ENVIRONMENTAL ENGINEERING**	
24CEH719	STRUCTURAL DYNAMICS	24CEH729	ADVANCED SOIL MECHANICS	24CEH739	HYDROINFORMATICS

24CEP701	CONSTRUCTION PROJECT MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	2	0	5	4	2024

Preamble: The course introduces the students to the concepts of construction project management and planning. The course sheds light on the techniques for planning and scheduling construction projects and monitoring and control of the projects in addition to providing insight into the applications of Building Information Modelling (BIM) in construction. By reinforcing the theoretical concepts with practical exercises in various software, it is envisaged that the students will become adept in construction project planning and management at the end of the course.

Prerequisite: Nil

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

CO1	Describe the procedure for planning and executing public works. (Understand Level)
CO2	Prepare the Bill of Quantities for a construction project. (Apply Level)
CO3	Apply scheduling techniques in construction project planning. (Apply Level)
CO4	Optimize resource requirements in construction projects. (Apply Level)
CO5	Apply earned value analysis for monitoring the schedule and cost performance of construction projects. (Apply Level)
CO6	Demonstrate the application of BIM in construction management and planning. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	1	-
CO2	3	3	-	-	-	-	-	2	-	1	2	-
CO3	3	3	-	-	3	-	-	2	-	1	2	-
CO4	3	3	2	-	3	-	-	2	-	-	3	-
CO5	3	3	-	-	3	-	-	2	-	-	3	-
CO6	3	3	-	-	3	-	-	2	-	2	2	-

Assessment Pattern for Theory component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Assessment Pattern for Lab Component

Bloom's Category	Continuous Assessment Tools	
	Classwork	Test1

Remember	✓	✓
Understand	✓	✓
Apply	✓	✓
Analyse		
Evaluate		
Create		

Mark Distribution of CIA							
Course Structure [L-T-P-J]	**Attendance**	**Theory [L]**			**Practical [P]**		**Total Marks**
		Assignment	**Test-1**	**Test-2**	**Class work**	**Lab Exam**	
3-0-2-0	**5**	**10**	**12.5**	**12.5**	**10**	**10**	**60**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	60	40	2.5hrs

End Semester Examination [ESE]: Pattern

PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 2		2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 2.5 hours	40
	Total Marks: 0	Total Marks: [5×8 = 40 marks]	

SYLLABUS
MODULE I (Construction Project Initiation and Planning)
Construction projects, life cycle of a project – phases in a project. Tendering: types of tenders, stages in tendering. Contracts: Importance of contracts, Types of Contracts – item rate contract, lumpsum contract, percentage rate contract, turnkey contracts, cost plus contracts, concession contracts – BOT, parties to a contract.

Common contract clauses (CPWD and FIDIC contract conditions) – Delays, penalties and liquidated damages, Force Majeure, Suspension and Termination, Changes and variations, Dispute Resolution.
Exercise in the development of BOQ for a residential building.

MODULE II (Scheduling)

Process of development of plans and schedules – work break-down structure, estimating durations.
Types of Schedules – Construction schedule, Material schedule, labour schedule, equipment schedule, financial schedule.
Techniques of planning – Bar charts, Mile Stone Charts.
Network representation – Activity on Node (AoN) Diagram.
Network analysis – Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT) – concepts and problems.
Precedence Diagramming Method – types of relationships – concept of lead and lag.
Exercises in software for project scheduling.

MODULE III (Resource Planning)

Handling resources on projects, resource constraints and conflicts, resource allocation and resource levelling.
Time-Cost trade-off on construction projects – Classification of costs, compression of networks, cost optimization through the crashing of a network.
Exercises in software for resource-constrained scheduling.

MODULE IV (Project monitoring and control)

Updating project schedules.
Project control, Schedule/time/progress control, periodic progress reports.
Time-cost monitoring and control using S-curve, Earned value analysis – measures of performance.
Exercises in software for project control.

MODULE V (Building Information Modelling)

Introduction to BIM Technology: Define BIM and BIM model, Describe workflow in using BIM in the building lifecycle, Model-Based cost estimating, Perform Simulations, Apply BIM to reduce error and change orders in projects, Evaluate and communicate ideas related to the use of BIM in the building life cycle, BIM Benefits: Case Studies, Organizational Maturity and Dimensions, Construction Management and Planning using BIM.
Exercises with Building Information Modelling Software in visualization.

Text books

1. Jha K. N., Construction Project Management Theory & Practice, Pearson India Education Services Pvt. Ltd., 2nd edition, 2015.
2. Sengupta B. and Guha H., Construction Management and Planning, McGraw Hill, 1995.
3. Hardin B. and McCool D., BIM and Construction Management: Proven Tools, Methods and Workflows, John Wiley and Sons Inc., 2015.

Reference books

1. Moder J. J., Philips C. R. and Davis E. W., Project Management with CPM, PERT and Precedence Diagramming, Van Nostrand Reinhold Company Inc., 1983.

2. Patrick C., Construction Project Planning and Scheduling, Dorling Kindersley India Pvt. Ltd., 2012.
3. Halpin D. W. and Senior B. A., Construction Management, John Wiley and Sons Inc., 4th Edition, 2011.
4. Harris F., McCaffer R., Baldwin A. and Edum-Fotwe F., Modern Construction Management, Wiley-Blackwell, 8th Edition, 2021.
5. Sharma S. C. and Deodhar S. V., Construction Engineering and Management, Khanna Publishing, 2019.
6. Joy P. K., Handbook of Construction Management, Macmillan, 2nd edition, 2000.
7. Chitkara, K. K. Construction Project Management: Planning, Scheduling and Controlling, Tata McGraw-Hill Education, 3rd Edition, 2014.
8. Bennett F. L., The Management of Construction: A Project Life Cycle Approach, Routledge, 2003.
9. Oberlender, G. D., Project Management for Engineering and Construction, McGraw-Hill, 2000.
10. Wiest, J. D. and Levy, F. K., A Management Guide to PERT/CPM, Prentice Hall, 2nd edition, 2003.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (8 Hours)	
1.1	Construction projects, life cycle of a project – phases in a project.	1
1.2	Tendering: types of tenders. Stages in tendering – advertisement of tenders.	1
1.3	Stages in tendering – submission, opening, scrutiny of tenders, award of contract.	1
1.4	Importance of contracts, Types of contracts – item rate contract, lumpsum contract, percentage rate contract.	1
1.5	Types of contracts – turnkey contracts, cost plus contracts, concession contracts – BOT, parties to a contract.	1
1.6	Common contract clauses (CPWD and FIDIC contract conditions) – Delays, penalties and liquidated damages.	1
1.7	Force Majeure, Suspension and Termination, Changes and variations.	1
1.8	Dispute Resolution.	1
	MODULE II (9 Hours)	
2.1	Process of development of plans and schedules – work break-down structure, estimating durations.	1
2.2	Types of Schedules – Construction schedule, Material schedule, labour schedule, equipment schedule, financial schedule.	1
2.3	Techniques of planning – Bar charts, Mile Stone Charts.	1

2.4	Network representation – Activity on Node (AoN) Diagram.	1
2.5	Network analysis – Critical Path Method (CPM) – determination EST, EFT, LST, LFT – identification of critical path.	1
2.6	CPM – computation of free float, independent float and interfering float.	1
2.7	Programme Evaluation and Review Technique (PERT) – three time estimates – computation of expected time.	1
2.8	PERT – calculation of the probability of completion.	1
2.9	Precedence Diagramming Method – types of relationships – concept of lead and lag.	1
MODULE III (6 Hours)		
3.1	Handling resources on projects, resource constraints and conflicts, resource histograms.	1
3.2	Resource allocation problem.	1
3.3	Resource levelling problem.	1
3.4	Time-Cost trade-off on construction projects – Classification of costs.	1
3.5	Compression of networks, cost optimization through the crashing of a network.	1
3.6	Problem on crashing.	1
MODULE IV (6 Hours)		
4.1	Updating of project schedule.	1
4.2	Project control.	1
4.3	Schedule/time/progress control, periodic progress reports.	1
4.4	Time-cost monitoring and control – S-curve.	1
4.5	Earned value analysis – measures of performance.	1
4.6	Problem on earned value analysis.	1
MODULE V (7 Hours)		
5.1	Introduction to BIM Technology: Define BIM and BIM model, Describe workflow in using BIM in the building lifecycle.	1
5.2	BIM Model-based cost estimating.	1
5.3	Performing Simulations.	1
5.4	Apply BIM to reduce error and change orders in projects.	1
5.5	Evaluate and communicate ideas related to the use of BIM in the building life cycle, BIM Benefits.	1
5.6	Case Studies, Organizational Maturity and Dimensions.	1
5.7	Construction Management and Planning using BIM.	1

LESSON PLAN FOR LAB COMPONENT

No.	Topic	No. of Hours	Experiment
1	Exercises in the development of BOQ for a residential building	2	Develop BOQ for a residential building.
2	Exercises in software for project scheduling	2	Develop a Gantt chart/ Precedence Network for a residential building project.
		2	Identify the critical path and floats.
3	Exercises in software for resource-constrained scheduling	2	Develop a resource schedule for a residential building.
4	Exercises in software for project control	2	Monitor the cost and schedule performance of a residential building.
5	Exercise with Building Information Modelling Software	2	Prepare the architectural drawing of a residential building.
		2	Prepare building model from the architectural drawing of a residential unit.
		2	Determine the quantities of the items of work in the residential building.
		2	Prepare schedule for the residential building.
		2	Develop the BIM model of the residential building.
		2	Develop the BIM model of the residential building.
6	Lab Exam	2	

CO Assessment Questions

CO 1	1. Explain the life cycle of a construction project. 2. Describe the process of finalizing a construction contract. 3. Explain any four types of contracts with their relative advantages and disadvantages.
CO 2	Develop the BOQ for a residential building.
CO 3	The details of a project are given.

Activity	A	B	C	D	E	F	G	H	I	J	K
Predecessor	--	--	--	A	B	B	C	C	D, E	F, G	H
Duration, weeks	3	5	1	1	7	6	4	3	6	4	3

<table>
<tr><td></td><td>(i) Identify the critical path.
(ii) Find the project duration.
(iii) Determine the total, free and interfering floats of all activities.</td></tr>
<tr><td>CO 4</td><td>The activities, predecessors, duration and resource requirements are given in the table below. Level the resources to make the requirements as uniform as possible.
<table>
<tr><td>Activity</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td></tr>
<tr><td>Predecessor</td><td>-</td><td>-</td><td>-</td><td>-</td><td>A</td><td>B</td><td>D,E</td><td>G,F</td></tr>
<tr><td>Duration (days)</td><td>2</td><td>2</td><td>4</td><td>2</td><td>2</td><td>3</td><td>3</td><td>4</td></tr>
<tr><td>Resource units per day</td><td>6</td><td>3</td><td>9</td><td>4</td><td>7</td><td>8</td><td>2</td><td>1</td></tr>
</table></td></tr>
<tr><td>CO 5</td><td>Calculate the Cost Variance, Cost Performance Index, Schedule Variance and the Schedule Performance Index and analyse the cost and schedule performance for each of the projects if the Budgeted Cost of Work Scheduled, Budgeted Cost of Work Performed and the Actual Cost of Work Performed are given below:
<table>
<tr><td></td><td>BCWS</td><td>BCWP</td><td>ACWP</td></tr>
<tr><td>1</td><td>5,00,000</td><td>5,00,000</td><td>5,00,000</td></tr>
<tr><td>2</td><td>5,00,000</td><td>4,00,000</td><td>6,00,000</td></tr>
<tr><td>3</td><td>4,00,000</td><td>4,00,000</td><td>5,00,000</td></tr>
</table></td></tr>
<tr><td>CO 6</td><td>Prepare BIM model of a residential building.</td></tr>
</table>

24HUT702	FINANCE AND ACCOUNTING FOR ENGINEERS	L	T	P	J	S	C	Year of Introduction
		2	1	0	0	2	3	2024

Preamble: The course provides a fundamental understanding of the concepts of finance and accounting, which is a requirement for modern day civil engineers owing to the changing paradigm of the construction industry, with the government trying to play more of a regulatory role, and its withdrawal from financial commitments, and the space being occupied by financial institutions. The course details the fundamental concepts of engineering economics, construction accounting, financial management and basic tools used in the economic decision making of construction projects. The course helps the students acquire knowledge on basic financial management aspects and economics to facilitate the process of economic decision making effectively.

Prerequisite: Nil

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

CO1	Describe the principles and process of construction accounting. (Understand Level)
CO2	Prepare financial statements and apply revenue recognition methods. (Apply Level)
CO3	Explain the basics of financial management and sources of finance for construction projects. (Understand and Apply Level)
CO4	Apply the concepts of engineering economics in evaluating alternatives by equivalence. (Apply Level)
CO5	Apply basic analysis tools like rate of return, benefit cost, and breakeven analysis in economic decision making. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	1	-
CO2	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	2	-
CO4	3	-	-	-	-	-	-	-	-	-	3	-
CO5	3	-	-	-	-	-	-	-	-	-	3	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
2-1-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern:

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Introduction to Accounting)

Introduction to Book keeping and Accounting — Accounting Process – Purpose of accounting – Classification of accounting – Generally Accepted Accounting Principles – Conventions and Concepts – Double entry system of accounting – Preparation of Journal, Ledger and Trial Balance. (Illustrative problem)

MODULE II (Construction Accounts Management)

Construction contract revenue recognition – methods – Construction Contract Status Report.

Introduction to financial statements – Preparation of Profit & Loss Account and Balance Sheet. (Simple problems)

MODULE III (Financing of Construction Projects)

Working capital – Operating cycle – Working capital management – Sources of finance - long term and short term financing.

Financing of PPP projects – Sources of project finance – Providers of finance – Financial structure – Financial indicators – Special nature of infrastructure financing need.

MODULE IV (Construction Economics)

Construction Economics – Definition and scope.
Time value of money – Simple and Compound interest – Time value equivalence – Cash flow diagrams – Interest calculations – Compound interest factors – Interest tables.
Evaluating alternatives by equivalence – Present worth comparison – Future worth comparison – Annual cost and worth comparison. (Problems on comparison of alternatives with equal lives only)

MODULE V (Methods of Economic decision making)

Rate of Return method – Minimum attractive rate of return (MARR), Internal Rate of Return (IRR) – Economic Decision Making using Incremental Rate of Return (IRoR) Analysis of public projects – Benefit cost analysis – applications.
Breakeven analysis – Fixed and variable cost – Total cost – Breakeven point and breakeven chart– Interpretation, limitations.
(Problems on comparison of alternatives with equal lives only)

Text books

1. Kumar Neeraj Jha, Construction Project Management, 2nd ed. Pearson, Dorling Kindersley (India) Pvt. Ltd, 2015.
2. Leland Blank, and Anthony Tarquin, Engineering Economy, Seventh Edition, McGraw Hill, 2012.

Reference books

1. Khan M.Y. and Jain P.K., Basic Financial Management, Tata McGraw Hill, Delhi.
2. Narayana Swamy R., Financial Accounting, PHI, Delhi, 2011.
3. Chandra, Prasanna, Financial Management, Tata McGraw Hill, Delhi, 2011.
4. Agrawal, R. and Sriniwasan, R., Accounting Made Easy, New Delhi: Tata McGraw-Hill, 2005.
5. Schexnayder, C.J. and Mayo, R.E., Construction Management Fundamentals, Singapore: McGraw-Hill, 2004.
6. Frank Harris and Ronald McCaffer, Modern Construction Management, Third Edition, BSP Professional books, Britain, 1989.
7. Sharan, V., Fundamentals of Financial Management, New Delhi: Pearson Education, 2005.
8. Theusen G.J. and Fabrycky W.J., Engineering Economy, 9th Edition, Prentice-Hall, Inc., New Delhi, India, 2001.
9. Crundwell F.K., Finance for Engineers-Evaluation and Funding of Capital Projects, Springer, London, UK, 2008. (ISBN 978-1-84800-032-2).
10. Riggs, J.L., Dedworth, Bedworth, D.B., Randhawa, S.U., Engineering Economics, McGraw Hill International Edition, 1996.

Note: Interest tables can be permitted for examination.		
COURSE CONTENTS AND LECTURE SCHEDULE		
No.	Topic	No. of hours (36)
MODULE I (7 Hours)		
1.1	Introduction to Book keeping and Accounting.	1
1.2	Accounting Process, Purpose of accounting.	1
1.3	Classification of accounting.	1
1.4	Generally Accepted Accounting Principles – Conventions and Concepts.	1
1.5	Double entry system of accounting.	1
1.6	Preparation of Journal, Ledger and Trial Balance.	1
1.7	Illustrative problem on the preparation of Journal, Ledger and Trial Balance.	1
MODULE II (7 Hours)		
2.1	Construction contract revenue recognition – methods.	1
2.2	Tutorial. (Methods for demarcating revenue recognition)	1
2.3	Construction Contract Status Report.	1
2.4	Introduction to financial statements.	1
2.5	Preparation of Profit & Loss Account.	1
2.6	Preparation of Balance Sheet.	1
2.7	Tutorial. (Preparation of Profit & Loss Account and Balance Sheet)	1
MODULE III (6 Hours)		
3.1	Working capital – Operating cycle – Working capital management.	
3.2	Tutorial. (Working capital)	1
3.3	Sources of finance - long term financing.	1

3.4	Sources of finance - short term financing.	1
3.5	Financing of PPP projects – Sources of project finance – Providers of finance.	1
3.6	Financial structure – Financial indicators – Special nature of infrastructure financing need.	1
MODULE IV (9 Hours)		
4.1	Construction Economics – Definition and scope, Time value of money, Simple and Compound interest, Time value equivalence, Cash flow diagrams.	1
4.2	Interest calculations – Compound interest factors, Interest tables.	1
4.3	Illustration of numerical problems using compound interest factors and interest tables.	1
4.4	Tutorial. (Compound interest factors and Interest tables)	1
4.5	Evaluating alternatives by equivalence – Present worth comparison. (Problems on comparison of alternatives with equal lives only)	1
4.6	Future worth comparison. (Problems on comparison of alternatives with equal lives only)	1
4.7	Tutorial. (Present worth comparison, future worth comparison)	1
4.8	Annual cost and worth comparison. (Problems on comparison of alternatives with equal lives only)	1
4.9	Tutorial. (Annual cost and worth comparison)	1
MODULE V (7 Hours)		
5.1	Rate of Return method – Minimum attractive rate of return (MARR), Internal Rate of Return (IRR).	1
5.2	Economic Decision Making using Incremental Rate of Return (IRoR). (Problems on comparison of alternatives with equal lives only)	1
5.3	Tutorial. (Internal Rate of Return, Incremental Rate of Return)	1
5.4	Analysis of public projects – Benefit cost analysis (Problems on comparison of alternatives with equal lives only) – applications.	1
5.5	Breakeven analysis – Fixed and variable cost – Total cost – Breakeven point and breakeven chart– Interpretation, limitations.	1
5.6	Illustration of numerical problems using breakeven analysis. (Problems on comparison of alternatives with equal lives only)	1

5.7	Tutorial. (Benefit cost analysis, breakeven analysis)	1

CO Assessment Questions

CO1

1. Describe the principles of accounting.
2. Explain the process of accounting.

CO2

1. For the set of data given in table below, calculate the revenue using the following methods of revenue recognition: (1) cash method of revenue recognition, (2) straight accrual method of revenue recognition, (3) completed contract method of revenue recognition, and (4) percentage of completion method of revenue recognition.

Sl. No.	Description	Amount (Rs.)
1	Contract amount	20,00,000
2	Original estimated cost	18,00,000
3	Billed to date	15,00,000
4	Payments received to date	13,00,000
5	Costs incurred to date	9,00,000
6	Forecasted costs to complete	8,50,000
7	Costs paid to date	8,00,000

2. From the transaction details of a construction company, M/s New Construction Limited, given in the Table. Assume all transactions to be cash transactions. Also, assume depreciation of machinery to be zero in this financial year. Prepare the profit and loss account and the balance sheet.

Table: Transaction details of M/s New Construction Company

Transaction	Reference	Description
1	T1	Purchased materials for INR 6,500
2	T2	Paid salaries INR 600
3	T3	Paid towards administrative charges INR 1,700
4	T4	Interest on loan paid INR 150
5	T5	Tax paid INR 70
6	T6	Sold goods for INR 9,500
7	T7	Borrowed loan from Citibank INR 3,150
8	T8	Purchased machinery for INR 3,150

CO3

1. Differentiate between short-term and long-term finance.
2. Tables shows the inter-firm comparison of construction companies. Calculate the net working capital for each of the companies and comment on them

Particulars	**ABC**	**CDE**	**EFG**	**HIJ**
Working capital (as % of sales)	28.94%	6.30%	27.33%	28.26%
Unadjusted advance (INR Lakh)	560	174	169	29
Unadjusted advance (as % of backlog)	6.28%	6.09%	5.05%	2.54%
Gross current assets (INR Lakh)	2704	442	539	256
Gross current assets (as a % of backlog)	70.18%	56.81%	79.62%	56.51%
Total liabilities and provisions (INR Lakh)	1589	392	354	128
Total liabilities and provisions (as a % of backlog)	41.24%	50.39%	52.29%	28.26%

CO4

1. A textile mill has installed several new looms. The expected maintenance costs for four years are given in the table. Determine the equivalent annual maintenance cost, if the interest rate is 10% compounded annually.

Year	**Maintenance cost (in INR)**
1	24000
2	18000
3	12000
4	6000

2. A company wishes to evaluate two alternative machines with the following characteristics:

Description	**Initial cost (Rs.)**	**Annual operating cost (Rs.)**	**Salvage value (Rs.)**	**Useful life in years**
Machine A	2,50,000	40,000	20,000	3
Machine B	3,70,500	50,00	30,000	3

Select the better alternative if i=10%.

CO5

1. A government is planning for a hydro-electric project. The established benefits and cost of three alternatives are given in the following table. The interest rate to be used for the analysis is 5% and the life of each of the alternatives X, Y, and Z is to be assumed as 50 years. Choose the best alternative.

Alternatives	**X**	**Y**	**Z**
Initial cost	250	350	500
Annual power sales	10	12	18
Annual flood control	2.5	3.5	5
Annual irrigation benefits	3.5	4.5	6
Annual recreation benefits	1	2	3.5
Annual operation and maintenance	2	2.5	3.5

(All values are in million of rupees)

2. A glass manufacturing company has four different alternatives to manufacture glass bottles. The details are given in the following table.

Description	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Initial cost (INR)	15,000	18,000	16,000	25,500
Net annual income (INR)	2,000	3,500	1,900	6,000
Salvage value (INR)	2,500	3,000	2,200	4,000
Useful life (Years)	10	10	10	10

If the MARR is 20% per year, then which of the alternative will be selected as the best alternatives among all?

24CED705	MAJOR PROJECT	L	T	P	J	S	C	Year of Introduction
		0	0	14	0	14	7	2024

Preamble: The goal of the course is to strengthen the students' understanding of fundamental concepts and to widen the horizon of their thinking in research by working on a recent research problem. The student should take up a problem in the identified area, perform investigations and interpret results. The course will provide an opportunity to identify technology/research gaps and propose innovative/creative solutions.

Prerequisite: Nil

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

CO1	Critically analyse existing literature in the chosen field, identify research gaps and opportunities for further investigation. (Analyse Level)
CO2	Define the research problem and formulate research objectives. (Apply Level)
CO3	Design and implement a well-structured research plan, outlining the key variables, hypotheses and experimental/analytical methods required to address the research questions. (Apply Level)
CO4	Interpret results effectively to draw meaningful conclusions. (Analyse and Evaluate Level)
CO5	Prepare a technical report and make effective presentations. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	-	-	-	3	3	-	-	3
CO2	3	3	-	3	-	-	-	-	3	-	-	3
CO3	3	3	3	3	1	-	-	-	3	3	2	3
CO4	3	2	3	-	-	-	-	-	3	3	-	3
CO5	3	-	-	-	-	-	-	3	3	3	-	-

Assessment Pattern

Bloom's Category	Continuous assessment tools		
	Evaluation 1	Evaluation 2	Evaluation 3
Remember			
Understand	✓	✓	✓
Apply	✓	✓	✓
Analyse	✓	✓	✓
Evaluate		✓	✓
Create			

Mark Distribution of CIA						
Course Structure [L-T-P-J]	Project guide	Interim Evaluation	Draft Report	Final Report	Final Evaluation	Total Marks
0-0-12-0	25	25	5	10	35	**100**

Total Mark distribution	
Total Marks	**CIA (Marks)**
100	100

General guidelines

- Choosing a topic
  - ❖ Research based mini project shall be executed as a group activity where each group can have a maximum of four students and shall identify a topic of interest in consultation with Mini Project Coordinator that shall lead to their dissertation/final year project. The topic may be chosen from the thrust areas of Civil Engineering stream or from interdisciplinary areas.
- Evaluation pattern
  - ❖ The progress of the Research based Mini Project is evaluated based on three reviews, two interim reviews and a final review. Students have to submit a report during the final review. Credits can be assigned to a student for research based mini project if he/she earns a pass grade in the final review.
- Evaluation committee
  - ❖ Continuous Internal Evaluation (CIE) Committee shall comprise of three members. Guide shall be one member in the CIE committee.
  - ❖ Final Evaluation Committee shall comprise of three members- department project coordinator, guide and a member nominated by Head of the Department.

24CEL706	DESIGN STUDIO	L	T	P	J	S	C	Year of Introduction
		0	0	2	0	2	1	2024

Preamble: The objective of this course is to impart and improve the design capability of the student. The course enables the students to familiarize themselves with the fundamental concepts of planning, analysis, design, and cost estimation of Civil Engineering Infrastructure. After the completion of this course, students gain confidence and expertise in the Civil Engineering domain such as structural engineering, transportation engineering, geotechnical engineering, and environmental engineering.

Prerequisite: Nil

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

CO1	Demonstrate creativity and problem-solving ability in planning a township. (Create Level)
CO2	Design, estimate, and prepare schedule of activities of a typical residential building. (Apply Level)
CO3	Prepare plan and design the services required for the proposed township. (Apply Level)
CO4	Prepare a technical report and make effective presentations. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	-	3	-	2	3	2	-	2
CO2	3	3	3	-	2	2	-	3	3	2	2	2
CO3	3	3	3	-	-	3	-	-	3	1	-	2
CO4	-	-	-	-	-	-	-	3	3	3	-	-

Assessment Pattern

	Continuous assessment tools		
	Evaluation 1	**Evaluation 2**	**Evaluation 3**
Remember			
Understand	✓	✓	✓
Apply	✓	✓	✓
Analyse	✓	✓	✓
Evaluate		✓	✓
Create	✓		

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Evaluation 1	Evaluation 2	Evaluation 3		Total Marks
				Presentation	Report	
0-0-2-0	5	5	15	20	5	50

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
50	50	-	-

Syllabus

Students should undertake a design problem for the following components of a development project

- Township planning
- Residential building including foundation (one representative building)
- Water supply and sanitation facilities
- Traffic and transport planning

The design problem can be allotted to a group of students comprising not more than four. The group should submit a complete report on the design consisting of the functional plan, analysis, design, cost estimation and scheduling (building only).

Text Books

1. S. U. Pillai and D. Menon, Reinforced Concrete Design, Tata McGraw-Hill, 3rd edition, 2009.
2. Manual on Sewerage and Sewage Treatment Systems, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 2013.
3. Manual on Water Supply and Treatment, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India, 1999.
4. V. N. S. Murthy, Advanced foundation Engineering, CBS Publishers & Distributors, 2011.
5. L.R. Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, 2013.

Reference

1. J.E. Bowles, Foundation Analysis and Design, McGraw-Hill, 2001.
2. J. Macgregor and J. K. Wight, Reinforced Concrete: Mechanics and Design, Prentice Hall, 5th edition, 2008.
3. J. C. Crittenden, R. R. Trussell, D. W. Hand, K. J. Howe, G. Tchobanoglous, MWH's Water Treatment: Principles and Design, 3rd Edition, John Wiley & Sons, 2012.
4. S. R. Qasim, Wastewater Treatment Plants: Planning, Design, and Operation, Second Edition, CRC Press, 1998.
5. Reinforced Concrete Structure, Park. R and Paulay. T, MISL-WILEY – Series Edition, 2009.
6. SP 34 Handbook on concrete reinforcement and detailing, Code of Practice, Bureau of Indian Standards.
7. Indian Standard Plain and Reinforced Concrete – Code of Practice (4th Revision),

IS 456: 2000, Bureau of Indian Standards.

LESSON PLAN

No.	Topic	No. of Class Hours (24)
1	Introduction and group formation	2
2	Township planning	2
3	Zeroth presentation (3rd week)	2
4	Residential building - functional plan, analysis, design, cost estimation and scheduling	6
5	Interim Evaluation (7th week)	2
5	Planning and design of Water supply and sanitation facilities	4
6	Traffic and transport planning	2
7	Final Evaluation and Presentation (11th and 12th weeks)	4

PROFESSIONAL ELECTIVE-3

24CEE713	STRUCTURAL DYNAMICS AND EARTHQUAKE RESISTANT DESIGN	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course aims to provide knowledge and skills in structural dynamics and design of earthquake-resistant structures. The course focuses on dynamic analysis of single and multi-degree systems and introduces Indian standard codes related to the analysis and design of structures for earthquake resistance. Upon completion of the course, students will possess the skills to conduct vibration analysis on building systems, calculate seismic design forces, and execute earthquake-resistant design for structural systems.

Prerequisite: 24CET401 Structural Analysis

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Recall principles and theorems related to structural dynamics. (Remember Level)
CO2	Perform dynamic analysis of single and multi-degree freedom systems. (Apply Level)
CO3	Describe various engineering aspects of earthquakes, earthquake effects and earthquake resistant design. (Understand Level)
CO4	Compute design seismic forces in building frames, applying relevant IS code provisions. (Apply Level)
CO5	Perform earthquake resistant design of structural members following the provisions in relevant IS codes. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	3	-	-	-	-	-	-	2
CO3	1	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	2	-	-	-	-
CO5	3	-	3	-	-	-	-	2	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

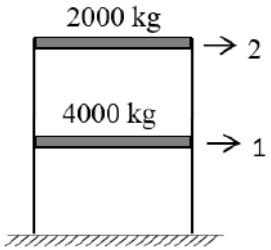
SYLLABUS
Module I (Single Degree of Freedom Systems)
Structural Dynamics – Review of SDOF systems, SDOF systems subjected to support motion, Dynamic magnification factor. Impulse response function, Duhamel's integral. SDOF systems subjected to support motion. Response spectrum.
Module II (Multi-Degree of Freedom Systems)
MDOF systems – shear building frames, Undamped free vibration – natural frequencies and mode shapes, orthogonality of modes. Mode superposition method – free and forced vibration responses, MDOF systems subjected to support motion.
Module III (Earthquake Engineering)
Engineering seismology, Earthquakes – causes, effects. Seismic waves, Size of earthquake – magnitude and intensity, Measurement of earthquakes, Strong motion characteristics, Earthquake response spectrum.

Module IV (Earthquake Resistant Building Construction)
Effect of earthquakes on structures, Damages during past earthquakes – case studies. Structural irregularities. Earthquake resistant building construction, Earthquake resistant design philosophy.
Module V (Code Based Analysis and Design)
Code based analysis and design – IS 1893 (Part 1), Design lateral force computation – Equivalent static method, Response spectrum method, Modal combination. Ductility – ductility factors, Ductile detailing considerations as per IS:13920, Shear walls.
Text books 1. Mario Paz, Structural Dynamics – Theory and Computation, CBS Publishers and Distributors, Delhi. 2. Anil K Chopra, Dynamics of Structures – Theory and Applications to earthquake Engineering, Prentice- Hall of India, New Delhi 3. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice- Hall of India, New Delhi. 4. Duggal S K, Earthquake Resistant Design of Structures, Oxford University Press, 2007. **Reference books** 1. Mukhopadhyay M, Structural Dynamics - Vibrations and Systems, Ane Books, India, Delhi. 2. Clough R W and Penzien J, Dynamics of Structures, McGraw Hill, New Delhi. 3. Biggs J M, Introduction to Structural dynamics, McGraw Hill, New Delhi. 4. Humar J, Dynamics of Structures, CRC Press, Netherlands. 5. IS 1893 (Part 1), Criteria for Earthquake Resistant Design of Structures (Part 1 General Provisions and Buildings), Bureau of Indian Standards, New Delhi. 6. IS 13920, Ductile Design and Detailing of Reinforced Concrete Structures subjected to Seismic Forces - Code of practice, Bureau of Indian Standards, New Delhi

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36)
Module I (7 Hours)		
1.1	Structural dynamics - Review of SDOF systems, free vibration, damping, response to harmonic loading – steady state response.	1
1.2	Dynamic magnification factor - Measurement of damping – half power bandwidth method.	1
1.3	Impulse response function (IRF) – undamped and damped systems.	1
1.4	Duhamel Integral – undamped and damped systems.	1
1.5	SDOF system subjected to support motion, equation of motion.	1
1.6	Working out problems - SDOF systems to support motion.	1
1.7	Response spectrum – Concept of pseudo velocity and pseudo acceleration response spectra.	1

Module II (9 Hours)		
2.1	Introduction to MDOF systems, shear building frames - equations of motion.	1
2.2	Undamped free vibration - Natural frequencies and mode shapes.	1
2.3	Orthogonality of mode shapes – proof.	1
2.4	Working out problems – Natural frequencies and mode shapes of MDOF systems.	1
2.5	Forced vibration analysis of MDOF systems – Mode superposition method.	1
2.6	Forced vibration analysis of MDOF systems.	1
2.7	MDOF system subjected to support motion- equation of motion.	1
2.8	Analysis of MDOF system due to support motion.	1
2.9	Working out problems – MDOF systems subjected to support motion.	1
Module III (6 Hours)		
3.1	Engineering seismology - Elastic Rebound Theory, Plate tectonics Earthquakes – terminology.	1
3.2	Seismic waves, Effect of earthquakes.	1
3.3	Size of earthquake – magnitude and intensity, moment magnitude.	1
3.4	Measurement of earthquakes – seismographs.	1
3.5	Strong motion characteristics, Earthquake response spectrum, Fourier spectrum.	1
3.6	Characteristics of response spectrum. Uses of earthquake response spectrum.	1
Module IV (6 Hours)		
4.1	Effect of earthquakes on structures, Damages during past earthquakes.	1
4.2	Case study of Bhuj Earthquake – lessons learned.	1
4.3	Structural irregularities.	1
4.4	Earthquake resistant building construction – Factors contributing to the proper seismic behavior of buildings.	1
4.5	Lateral load resisting systems.	1
4.6	Earthquake resistant design philosophy.	1
Module V (8 Hours)		
5.1	Code based analysis and design methods – Introduction to IS 1893 (Part 1).	1
5.2	Design lateral force computation – Equivalent static method.	1
5.3	Design lateral force computation – Response spectrum method.	1
5.4	Modal combination rules.	1
5.5	Ductility – significance in earthquake resistant design, Ductility factors.	1
5.6	Ductile detailing considerations as per IS 13920, Design and detailing of structural members and joints.	1

5.7	Shear Wall – Code provisions.	1
5.8	Shear Wall design.	1

CO Assessment Questions	
CO1	State and explain Mode Superposition Method.
CO2	For the frame shown in figure the natural frequencies are 15.81 rad/s and 31.62 rad/s. The modal matrix $\Phi = \begin{bmatrix} 1 & 1 \\ 2 & -1 \end{bmatrix}$. Obtain the response of the floors due to a constant ground acceleration of 2 m/s^2. Also, calculate the floor displacements at $t = 1$ s. 
CO3	What are the factors which a designer should consider to ensure proper seismic behavior of a building? Explain all.
CO4	A four storey building has seismic weights 10 kN, 10 kN, 8 kN and 6 kN respectively in the 1st, 2nd , 3rd and 4th floors. The natural frequencies are 5.53, 14.59, 22.66 and 26.86 rad/s. The modal matrix is $\begin{bmatrix} 1.00 & 1.00 & 1.00 & 1.00 \\ 1.85 & 0.94 & -0.57 & -1.61 \\ 2.51 & -0.31 & -0.70 & 2.14 \\ 2.82 & -1.24 & 0.86 & -1.39 \end{bmatrix}$. Using response spectrum method, calculate the lateral forces at the various floor levels. Use SRSS rule to combine the modal responses. Assume that the building is to be constructed in Zone IV and the foundation soil is Type II (medium soil). The frame may be assumed as SMRF. Take importance factor as 1.5.
CO5	A shear wall of length 8 m and thickness 200 mm has to resist an axial force of 3900 kN, SF of 780 kN and a BM of 19000 kNm. Design the shear wall using M25 concrete and Fe 415 grade steel. Sketch the reinforcement details.

24CEE723	ADVANCED STRUCTURAL ANALYSIS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course helps the students to understand the advance concepts in structural analysis. It majorly covers some additional methods in analysis of statically indeterminate structures such as moment distribution method, matrix method of analysis, approximate method of analysis etc. After the completion of the course the student will be able to do the structural analysis of multi stories structures using the fundamentals.

Prerequisite: 24CET401 Structural Analysis

Course Outcomes:

After the completion of the course the student will be able to

CO1	Analyse indeterminate structures such as continuous beams and portal frames by moment distribution method. (Apply Level)
CO2	Analyse structures using approximate methods. (Apply Level)
CO3	Analyse continuous beams, rigid frames and plane trusses by direct stiffness method. (Apply Level)
CO4	Analyse continuous beams, rigid frames and plane trusses by stiffness method. (Apply Level)
CO5	Analyse continuous beams, rigid frames and plane trusses using flexibility method. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L-T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS
Module I (Analysis of Statically Indeterminate Structures)
Moment Distribution Method: carry over factor, distribution factor. Analysis of continuous beams and portal frames – sway and non-sway frames.
Module II (Approximate Methods of Analysis of Multistoried Frames)
Analysis for vertical loads - substitute frames - loading condition for maximum hogging and sagging moments in beams and maximum bending moment in columns. Wind load analysis of multistoried frames – portal method and cantilever method for lateral load analysis.
Module III (Matrix Analysis of Structures: Direct Stiffness Method)
Development of stiffness matrices by physical approach - stiffness matrices for truss and frame elements Stiffness. Introduction to direct stiffness method - stiffness matrix of elements in global co-ordinates from element co-ordinates - Assembly of load vector and stiffness matrix, solution of two span continuous beams - single bay single storey portal frames. Rotation of axes in two dimensions, analysis of trusses using direct stiffness method.

Module IV (Matrix Analysis of Structures: Stiffness Method)
Stiffness method: displacement transformation matrix - analysis of simple structures - Analysis of continuous beams, plane frame (non-sway and sway frames) - plane truss - lack of fit and temperature effects.
Module V (Matrix Analysis of Structures: Flexibility Method)
Flexibility method: flexibility influence coefficients - flexibility matrices for truss and frame elements - load transformation matrix - development of total flexibility matrix of the structure - nodal loads and element loads - analysis of simple structures - continuous beams, plane truss and plane frame - lack of fit and temperature effects.

Text Books:

1. Pandit G S and S P Gupta, Structural analysis a Matrix approach, McGraw Hill Education (India), 2008.
2. Devdas Menon, Structural Analysis, Narosa Publishing House, 2008.
3. Gere, J M and William Weaver, Matrix Analysis of framed structures, CBS Publishers, 1990.
4. Kenneth M Leet, Chia Ming Uang, Anne M Gilbert, Fundamentals of structural analysis, Tata McGraw Hill Pvt Ltd., 4e, 2010.
5. Reddy C S, Basic structural analysis, Tata McGraw Hill, third edition, 3e, 2012.

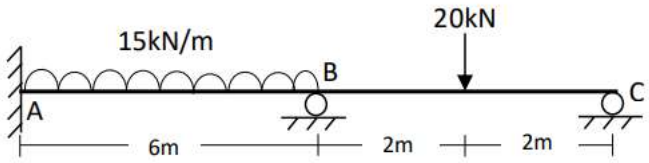
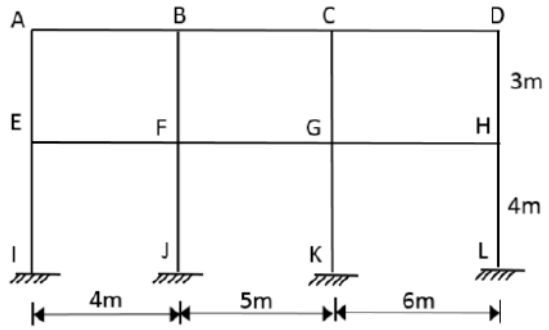
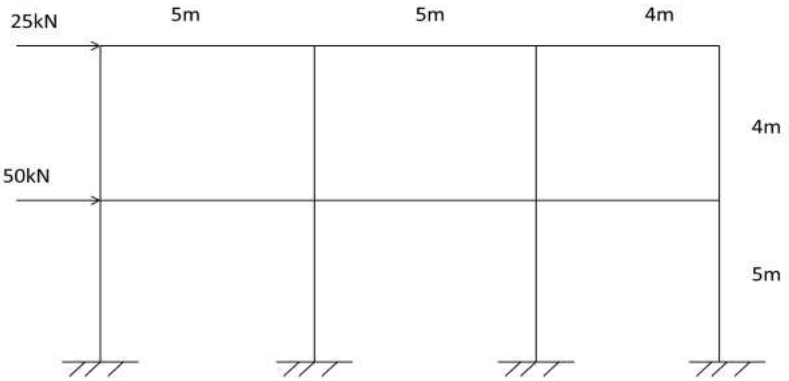
Reference Books:

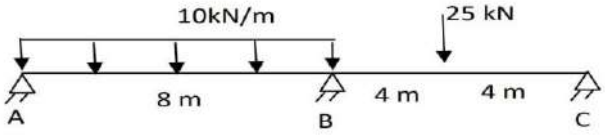
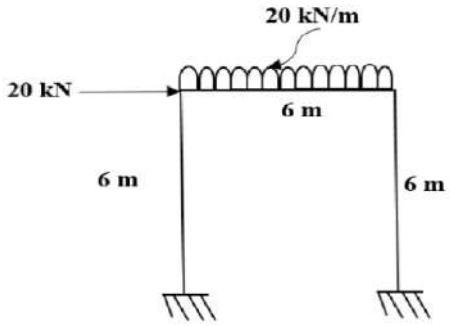
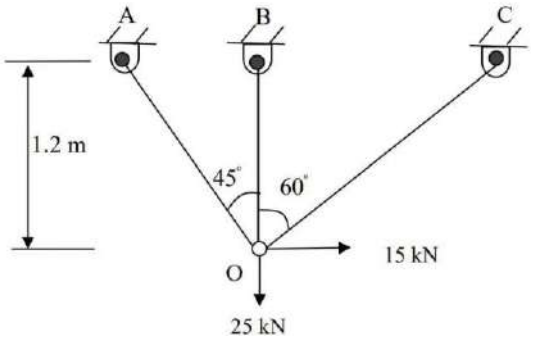
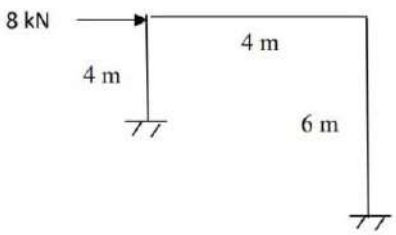
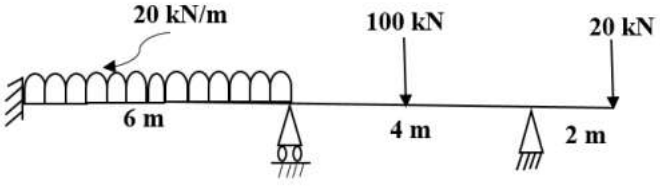
1. Madhujith Mukhopadhyay and Abdul Hamid Sheikh, Matrix and Finite Element Analysis of Structures, Ane Books India, 2009.
2. Rajasekharan S and G Sankarasubramanian, Computational structural Mechanics, PHI, 2009.
3. Devdas Menon, Advanced Structural Analysis, Narosa Publishing House, 2009.
4. Wang C K, Matrix method of structural analysis, International Text book company, 1970.
5. Hibbeler R C, Structural Analysis, Pearson Education, 2017.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36)
Module I (6 Hours)		
1.1	Recall on Degree of static and kinematic indeterminacies – Introduction to force and displacement methods.	1
1.2	Moment Distribution Method: Concepts, Distribution factor, Carry over factor.	1
1.3	Analysis of continuous beams.	1
1.4	Numerical problems.	1
1.5	Analysis of non-sway portal frames.	1
1.6	Analysis of Sway frames.	1
Module II (7 Hours)		

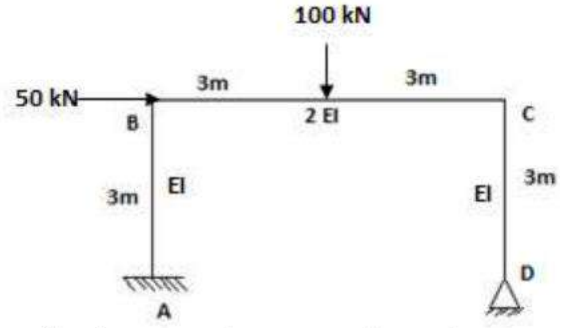
2.1	Introduction to approximate methods of analysis of multistoried frames, analysis for vertical loads - substitute frames. Loading condition for maximum hogging and sagging moments in beams and maximum bending moment in columns.	1
2.2	Numerical problems on substitute frame method.	1
2.3	Numerical problems on substitute frame method.	1
2.4	Wind load analysis of multistoried frames – portal method.	1
2.5	Wind load analysis of multistoried frames – portal method.	1
2.6	Wind load analysis of multistoried frames –cantilever method.	1
2.7	Wind load analysis of multistoried frames –cantilever method.	1
Module III (8 Hours)		
3.1	Recall to matrix analysis of structures: Definition of stiffness influence coefficients.	1
3.2	Development of stiffness matrices by physical approach - Stiffness matrices for truss and frame elements.	1
3.3	Introduction to direct stiffness method - stiffness matrix of elements in global co-ordinates from element co-ordinates.	1
3.4	Assembly of load vector and stiffness matrix.	1
3.5	Analysis of two span continuous beams.	1
3.6	Single bay single storey portal frames.	1
3.7	Rotation of axes in two dimensions, analysis of trusses using direct stiffness method.	1
3.8	Numerical examples.	1
Module IV (7 Hours)		
4.1	Stiffness method: -displacement transformation matrix.	1
4.2	Analysis of continuous beams.	1
4.3	Analysis of plane frame. (non-sway frames)	1
4.4	Analysis of plane frame. (sway frames)	1
4.5	Analysis of plane truss.	1
4.6	Numerical examples.	1
4.7	Lack of fit and temperature effects.	1
Module V (8 Hours)		
5.1	Flexibility method: flexibility influence coefficients - flexibility matrices for truss and frame elements.	1

5.2	Load transformation matrix - development of total flexibility matrix of the structure - nodal loads and element loads.	1
5.3	Analysis of continuous beams.	1
5.4	Analysis of plane frame. (non-sway frames)	1
5.5	Analysis of plane frame. (sway frames)	1
5.6	Analysis of plane truss.	1
5.7	Numerical examples.	1
5.8	Lack of fit and temperature effects.	1

CO Assessment Questions	
CO 1	Analyse the continuous beam shown in figure using moment distribution method. Draw bending moment diagram and calculate support reactions. EI is constant. 
CO 2	1. Analyse the frame shown below for midspan positive moment on span FG, using Substitute frame method. Total dead load is 15kN/m and total live load is 30kN/m. Flexural rigidity EI is same for all members.  2. Analyse the frame shown in figure using Cantilever method. Area of cross section of all columns is same. 

CO 3	1. Analyse the continuous beam shown in figure using direct stiffness method. Take EI constant for all members.  2. Analyse the frame and draw bending moment diagram for the frame shown in Figure 4 using direct stiffness method. Take EI Constant. 
CO 4	1. Analyse the truss shown in figure using Stiffness Matrix Method. Axial rigidity is same for all the members.  2. Analyse the portal frame shown in figure using stiffness matrix method. Flexural rigidity is EI for column members and 2EI for the beam. 
CO 5	1. Analyse the continuous beam shown in figure using flexibility matrix method and find the bending moments. 

2. Analyse the frame shown in figure by flexibility method.



24CEE733	BUILDING SERVICES	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to provide students with a comprehensive understanding of essential building services and sustainable practices. The syllabus encompasses topics from water management and wastewater systems to electrical and mechanical services, firefighting, acoustics and green building automation. The course equips students with the knowledge and skills to understand and apply the critical elements of building services and sustainability that enable students to apply them in building planning and construction.

Prerequisite: 24CET503 Environmental Engineering

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

CO1	Explain various water management services and estimate the water consumption. (Understand and Apply Level)
CO2	Discuss the wastewater collection and conveyance system. (Understand Level)
CO3	Describe various electrical and mechanical building services. (Understand Level)
CO4	Discuss the various firefighting services. (Understand Level)
CO5	Explain relevant materials and practices for good acoustics. (Understand Level)
CO6	Explain the concept of green building and building automation. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	-	-	2	-	-	-	-	-	-
CO2	2	3	1	-	-	2	-	-	-	-	-	-
CO3	2	-	-	-	-	2	-	-	-	-	-	-
CO4	2	-	-	-	-	2	-	-	-	-	-	-
CO5	2	-	-	-	-	-	-	-	-	-	-	-
CO6	2	-	-	-	-	-	3	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools		End Semester Examination
	Test1	Test 2	
Remember	✓	✓	✓
Understand	✓	✓	✓
Apply	✓		✓
Analyse			
Evaluate			
Create			

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, with 2 questions from each module, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Water Management Services)

Pipes for water distribution, joints, fixtures and valves, water meters, etc. - Water storage tanks: capacity and location - water purifiers.

House/service connection, capacity of overhead tanks and calculation of water consumption. Domestic water piping system: Cold and hot water distribution within the building.

Terminology such as flow, pressure, head, etc. - principles of water supply in buildings (low-rise, multi-storeyed).

Rain water Harvesting - roof top harvesting, type of spouts, sizes of rainwater pipes, methods of rainwater harvesting – harvesting tanks and pit - typical details.

MODULE II (Liquid and Solid Waste Management Services)

Types of traps and chambers: inspection chamber, disconnecting chamber,

intercepting trap, Strap, P-trap, gully trap, grease trap - sanitary fixtures: washbasins, WCs, bathtubs, urinals, flushing cistern - Types of pipes and joints. Design principles of sanitary layout: location and ventilation of chambers, traps, fixtures - Building sanitation systems: separate, combined, single stack, one pipe and two pipe - On-site treatment: Septic tanks, Soak pits, Cesspool, dispersion trenches – decentralized treatment systems for multi-storeyed buildings (theory only, no design) - recycling grey water: practices. Solid waste quantity, Types and composition, characteristics, on-site processing and disposal methods.
MODULE III (Electrical and Mechanical services)
Electrical installations and Accessories of wiring (terminologies and symbols only), Systems of wiring, Electrical layout for residence, small workshop, show room, school building, etc. Air Conditioning: Types of Air Conditioners, (Central type, Window Type, Split Unit), capacity selection of air conditioner. Lift: Definition, Types of Lifts, Location, Sizes, Component parts - Elevators & Escalators: Different types of elevators and Escalators, Freight elevators, Passenger elevators, Hospital elevators - Uses of different types of elevators – Escalators – Dumbwaiters: Types and uses - Conveyors: Types and uses. Pumps – Types, Selection, installation, and maintenance.
MODULE IV (Fire and Acoustic Management Services)
Causes and Effects of fire, General Requirements of Fire Resisting building, Characteristics of Fire resisting materials, Maximum Travel Distance, Fire Fighting Installations for Horizontal Exit, Roof Exit / Fire Lifts, External Stairs - Firefighting equipment and different methods of fighting fire, means of escape, alarms etc. Requirement of good Acoustic - Factors to be followed for noise control in residential building - Acoustical Materials: Porous materials, panel absorbers, membrane absorbers, acoustical plasters, diffusers, cavity or Helmholtz resonators. Role of functional absorbers, Adjustable acoustics and variable sound absorbers. Acoustical correction and retrofits to existing spaces.
MODULE V (Miscellaneous Services)
Concept of Green buildings – Sustainable features of green building – LEED India rating system - energy efficiency, water efficiency – Green materials and equipment - waste reduction during construction, materials with recycled content, local materials, material reuse, certified wood, rapidly renewable building materials and furniture, HVAC. Concept of building automation - Design issues related to building automation and its effect on functional efficiency, Components of building automation system; modern security system, alarm system, fire-protection, inter-communication, monitoring devices, mechanical means of vertical and horizontal transportation, Intelligent lighting system etc.

Text books

1. Duggal, K. N., Elements of Environmental Engineering, S Chand and Co. Ltd., New Delhi, 2008.
2. Modi, P. N., Sewage Treatment and Disposal and Wastewater Engineering, Standard Book House, New Delhi, 2008.
3. Curd, E. F. and C. A. Howard, Introduction to building services, Macmillan, 1996.
4. Raina, K. B. and S. K. Bhattacharya, Electrical design estimating and costing, new age international Pvt. Ltd publishers, 2005.
5. David Egan, M., Architectural Accoustics, J. Ross Publisher, 2007.

Reference books

1. Birdie, G. S., and Birdie, J. S., Water Supply and Sanitary Engineering, Dhanpat Rai and Sons, New Delhi, 2007.
2. Rainwater harvesting and conservation manual, CPWD, GOI, 2002.
3. Arora, C. P., Refrigeration and Air Conditioning, Tata McGraw Hill, 2000.
4. Charles J. Kibert, Sustainable construction – Green building design and delivery, Wiley, 2016.
5. Chadderton, D. V., Building services engineering, Taylors & Francis Group.
6. National Building Code of India (NBC) 2005: Part 4 Fire and Life Safety.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (7 hours)	
1.1	Pipes for water distribution, joints, fixtures and valves, water meters etc.	1
1.2	Water storage tanks: capacity and location - water purifiers.	1
1.3	House/service connection, capacity of overhead tanks and calculation of water consumption.	1
1.4	Domestic water piping system: Cold and hot water distribution within the building.	1
1.5	Terminology such as flow, pressure, head, etc. - principles of water supply in buildings (low-rise, multi-storeyed).	1
1.6	Rainwater Harvesting - roof top harvesting, type of spouts, sizes of rainwater pipes.	1
1.7	Methods of rainwater harvesting – harvesting tanks and pit - typical detail.	1
	MODULE II (8 hours)	
2.1	Types of traps and chambers: inspection chamber, disconnecting chamber, intercepting trap, S-trap, P-trap, gully trap, grease trap.	1

2.2	Sanitary fixtures: washbasins, WCs, bathtubs, urinals, flushing cistern - Types of pipes and joints.	1
2.3	Design principles of sanitary layout: location and ventilation of chambers, traps, fixtures.	1
2.4	Building sanitation systems: separate, combined, single stack, one pipe and two pipe.	1
2.5	On-site treatment: Septic tanks, Soak pits, Cess pools, dispersion trenches.	1
2.6	Decentralized treatment systems for multi-storeyed buildings (theory only, no design).	1
2.7	Practices for Recycling grey water.	1
2.8	Solid waste quantity, Types and composition, characteristics.	
2.9	On-site processing and disposal methods.	1
MODULE III (7 hours)		
3.1	Electrical installations and Accessories of wiring (terminologies and symbols only), Systems of wiring.	1
3.2	Electrical layout for residence, small workshop, showroom, school building, etc.	1
3.3	Air Conditioning: Types of Air Conditioners, (Central type, Window Type, Split Unit), capacity selection of air conditioner.	1
3.4	Lift: Definition, Types of Lifts, Location, Sizes, Component parts.	1
3.5	Different types of elevators and Escalators, Freight elevators, Passenger elevators, Hospital elevators - Uses of different types of elevators.	1
3.6	Escalators – Dumbwaiters: Types and uses - Conveyors: Types and uses.	1
3.7	Pumps – Types, Selection, installation, and maintenance.	1
MODULE IV (7 hours)		
4.1	Causes and Effects of fire, General Requirements of Fire Resisting building as per IS and NBC 2005.	1
4.2	Characteristics of Fire resisting materials, Maximum Travel Distance, Fire Fighting Installations for Horizontal Exit, Roof Exit / Fire Lifts, External Stair.	1
4.3	Firefighting equipment and different methods of fighting fire, means of escape, alarms, etc.	1
4.4	Requirement of good Acoustic - Factors to be followed for noise control in residential buildings.	1

4.5	Acoustical Materials: Porous materials, panel absorbers, membrane absorbers, acoustical plasters, diffusers, cavity or Helmholtz resonators.	1
4.6	Role of functional absorbers, Adjustable acoustics and variable sound absorbers.	1
4.7	Acoustical correction and retrofits to existing spaces.	1
MODULE V (7 hours)		
5.1	Concept of Green buildings – Sustainable features of green building.	1
5.2	LEED India rating system - energy efficiency, water efficiency.	
5.3	Green materials and equipment - waste reduction during construction, materials with recycled content, local materials, material reuse, certified wood, Rapidly renewable building materials and furniture.	1
5.4	HVAC	1
5.5	Concept of building automation - Design issues related to building automation and its effect on functional efficiency.	1
5.6	Components of building automation system; modern security system, alarm system, fire-protection, intercommunication, monitoring devices.	1
5.7	Mechanical means of vertical and horizontal transportation.	1
5.8	Intelligent lighting system.	1

CO Assessment Questions	
CO1	1. Estimate the capacity of overhead tank required for a multi-storeyed apartment having 10 storeys with 5 houses in each storey. Assume necessary data. 2. Draw a layout of the hot water system within a building within a building.
CO2	1. Explain the types and functions of traps. 2. Illustrate various plumbing systems adopted for collection of waste water from a building.
CO3	1. Illustrate an electrical layout for a typical house, specifying the placement of outlets and switches. 2. Explain the differences between central, window and split unit air conditioners 3. Describe different types of elevators and their respective applications.

	4. Explain the installation and maintenance requirements for pumps.
CO4	1. Describe the general requirements for constructing fire-resisting buildings as per IS and NBC 2005. 2. Discuss the specific fire fighting installations and equipment required for horizontal exits in buildings.
CO5	1. Illustrate examples of materials and practices that can be used to improve acoustics in a residential building. 2. Explain the concept of acoustical correction and the process of retrofitting to improve sound quality in existing spaces.
CO 6	1. Explain the significance of HVAC systems in green buildings and their impact on energy efficiency. 2. Illustrate examples of energy-efficient and water-efficient practices commonly used in green building design and construction. 3. Discuss the concept of building automation and its role in the functional efficiency of buildings.

24CEE743	REPAIR AND REHABILITATION OF BUILDINGS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course provides the basic idea and needs of maintenance, repair, rehabilitation and strengthening measures for building structures. The course details the various deterioration and damage mechanisms in buildings, the damage diagnosis and assessment measures adopted in site, and the several materials and techniques commonly used in the repair of structures. The course helps the students to identify the deterioration and damage mechanisms in buildings and suggest evaluation and repair/maintenance methods for extending the service life of buildings.

Prerequisite: Nil

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

CO1	Describe the failures and damages in structures. (Understand Level)
CO2	Explain the causes of deterioration in concrete structures and methods of protection. (Understand Level)
CO3	Illustrate the procedure for maintenance, damage diagnosis and assessment of structure. (Understand Level)
CO4	Discuss the criteria for selection, types and properties of various repair materials used in site. (Understand Level)
CO5	Describe the various repair techniques which enable a structure to perform its designated function. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	1	-	-	-	-	-
CO2	3	-	-	-	-	-	1	-	-	-	-	-
CO3	3	-	-	-	-	-	2	-	-	-	-	-
CO4	3	-	-	-	-	-	2	-	-	-	-	-
CO5	3	-	-	-	-	-	1	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern:

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Failure and Damages in Buildings)

Introduction - Maintenance, rehabilitation, repair, retrofit and strengthening, need for rehabilitation of structures.

Failure of buildings – Definition of building failure – types of failures - Causes of Failures – Faulty Design, Accidental over Loading, Poor quality of material and Poor Construction practices – Quality control and quality assurance.

Distress and damages to concrete and masonry structures – various cracks in reinforced concrete buildings – causes and effects, various damages to masonry structures – causes.

MODULE II (Deterioration in Concrete Structures)

Introduction to embedded metal corrosion – Corrosion of embedded metal – significance and fundamentals of corrosion – mechanism – carbonation induced and chloride induced corrosion – Corrosion mechanism and control.

Deterioration of cementitious systems – Introduction – process of deterioration in structures and factors influencing – sulphate attack – biofouling – alkali-silica reaction – acid attack – concrete in sea water.
Effect due to moisture, temperature, abrasion and erosion, frost action, freeze-thaw, fire attack – effects of cover thickness and cracking.

MODULE III (Maintenance, Damage Diagnosis and Assessment)

Maintenance strategies- Objectives of maintenance, Facets, Factors influencing, benefits of good maintenance operation, routine and preventive maintenance.
Damage diagnosis and assessment - Various aspects of Inspection – Assessment procedure for evaluating a damaged structure – Visual inspection – Non Destructive Testing using Rebound hammer, Ultra sonic pulse velocity, Semi destructive testing, Pull out test, Core test, Load test.
Corrosion activity measurement – Chloride penetration test, Carbonation, Carbonation depth testing, Assessment including half-cell potential and resistivity, Mapping of data.

MODULE IV (Materials for Repair)

Repair materials - Various repair materials, Criteria for material selection, Methodology of selection, Health and Safety precautions for handling and applications of repair materials.
Special mortars and concretes - Polymer concrete and mortar, Sulphur infiltrated concrete, Fibre reinforced concrete, Vacuum concrete, Expansive cement, Ferrocement, Concrete chemicals.
Grouting materials - Gas forming grouts, Sulfoaluminate grouts, Polymer grouts, Acrylate and Urethane grouts.
Bonding agents – Latex emulsions, Epoxy bonding agents.

MODULE V (Techniques for Repair)

Concrete removal and preparation for repair – Introduction – General surface preparation procedures.
Crack repair - Various methods of crack repair – Grouting, Routing and sealing, Stitching, Epoxy injection.
Techniques for repair – Reinforcing steel cleaning, repair and protection – Rust eliminators and polymer coating for rebars – Bonding repair materials to existing concrete – Placement methods – dry packing, pre-packed aggregate, gunite and shotcrete.
Repairs to overcome low member strength – Jacketing - Column jacketing, Beam jacketing, Beam Column joint jacketing – Fibre Reinforced Polymer (FRP) jacketing – carbon fibre wrapping and carbon composites in repair.

Text books

1) Peter H. Emmons, Concrete Repair and Maintenance Illustrated: Problem Analysis, Repair Strategy, Techniques, R. S. Means Company, Kingston, 2002.
2) R. D. Woodson, Concrete Structures- Protection, Repair and Rehabilitation, Butterworth-Heinemann, UK, 2009.

Reference books

1) Denison Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical, UK, 1991.
2) M. S. Shetty, Concrete Technology – Theory and Practice, S. Chand and Company, New Delhi, 1992.
3) R. T. Allen and S. C. Edwards, Repair of Concrete Structures, Blakie and Sons, UK, 1987.
4) P. S. Gahlot and S. Sharma, Building Repair and Maintenance Management, CBS publishers, New Delhi, 2013.
5) Robert T. Ratay, Forensic Structural Engineering Handbook, Second Edition, The McGraw-Hill Companies, Inc., 2010.
6) Alexander Newman, Structural Renovation of Buildings: Methods, Details, and Design Examples, Second Edition, McGraw Hill Publications, 2021.
7) S. Champion, Failures and repair of concrete structures, John Wiley and Sons, 1961.
8) R. N. Raikar, Diagnosis, and treatment of structures in distress, R & D Centre of Structural Designers and Consultants Pvt. Ltd, Mumbai.
9) Dov Kominetzky, Design and Construction Failures, Galgotia Publications Pvt. Ltd., 2001.
10) K. Ravishankar and T. S. Krishnamoorthy, Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures, Allied Publishers, 2004.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (5 Hours)	
1.1	Introduction - Maintenance, rehabilitation, repair, retrofit and strengthening, need for rehabilitation of structures.	1
1.2	Failure of buildings – Definition of building failure – types of failure, Causes of Failures – Faulty Design, Accidental over Loading.	1
1.3	Poor quality of material and Poor Construction practices, Quality control and quality assurance.	1
1.4	Various cracks in reinforced concrete buildings – causes and effects.	1
1.5	Various damages to masonry structures – causes.	1
	MODULE II (8 Hours)	
2.1	Introduction to embedded metal corrosion – Corrosion of embedded metal – significance and fundamentals of corrosion.	1
2.2	Carbonation induced and chloride induced corrosion.	1
2.3	Corrosion mechanism.	1

2.4	Corrosion control.	1
2.5	Deterioration of cementitious systems – Introduction – process of deterioration in structures and factors influencing.	1
2.6	Sulphate attack.	1
2.7	Biofouling – acid attack.	1
2.8	Alkali-silica reaction – concrete in sea water.	1
MODULE III (8 Hours)		
3.1	Maintenance strategies - Objectives of maintenance, Facets, Factors influencing.	1
3.2	Benefits of good maintenance operation, routine and preventive maintenance.	1
3.3	Damage diagnosis and assessment - Various aspects of Inspection.	1
3.4	Assessment procedure for evaluating a damaged structure, Visual inspection.	1
3.5	Non Destructive Testing using Rebound hammer, Ultra sonic pulse velocity test.	1
3.6	Semi destructive testing, Pull out test, Core test, Load test.	1
3.7	Corrosion activity measurement – Chloride penetration test, Carbonation – Carbonation depth testing.	1
3.8	Assessment including half-cell potential and resistivity, Mapping of data.	1
MODULE IV (7 Hours)		
4.1	Repair materials - Various repair materials, Criteria for material selection.	1
4.2	Methodology of selection, Health and Safety precautions for handling and applications of repair materials.	1
4.3	Special mortars and concretes - Polymer concrete and mortar, Sulphur infiltrated concrete.	1
4.4	Fibre reinforced concrete, Vacuum concrete.	1
4.5	Expansive cement, Ferro cement, Concrete chemicals.	1
4.6	Grouting materials - Gas forming grouts, Sulfoaluminate grouts, Polymer grouts, Acrylate and Urethane grouts.	1
4.7	Bonding agents – Latex emulsions, Epoxy bonding agents.	1
MODULE V (8 Hours)		

5.1	Concrete removal and preparation for repair – Introduction – General surface preparation procedures.	1
5.2	Crack repair - Various methods of crack repair – Grouting, Routing and sealing.	1
5.3	Stitching, Epoxy injection.	1
5.4	Techniques for repair – Reinforcing steel cleaning, repair and protection – Rust eliminators and polymer coating for rebars.	1
5.5	Bonding repair materials to existing concrete.	1
5.6	Placement methods – dry packing, pre-packed aggregate, gunite and shotcrete.	1
5.7	Repairs to overcome low member strength – Jacketing - Column jacketing, Beam jacketing, Beam Column joint jacketing.	1
5.8	Fibre Reinforced Polymer (FRP) jacketing – carbon fibre wrapping and carbon composites in repair.	1

CO Assessment Questions	
CO1	Explain the different types of failure of structures.
CO2	Discuss on the mechanism of corrosion in reinforcing steel.
CO3	Explain the various facets of maintenance in concrete buildings.
CO4	Describe the properties and uses of Fibre reinforced concrete.
CO5	Describe the various underpinning methods and the circumstances with which it is provided.

24CEE753	ADVANCED FOUNDATION ENGINEERING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course provides a comprehensive understanding of geotechnical engineering principles and foundation design for various foundation types. It covers the load carrying capacity and settlement computations of a variety of foundations. The course equips the students with the knowledge and skills to evaluate bearing capacity, design various types of foundations, and analyze the stability and load-carrying capacity of geotechnical structures, enabling them to apply these principles in real-world engineering scenarios.

Prerequisite: 24CEJ502 Foundation Engineering

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

CO1	Describe allowable soil pressure and safe bearing capacity, evaluate safe bearing capacity of shallow foundations by IS formula. (Understand and Apply Level)
CO2	Design pile foundations, evaluate settlement of pile groups, uplift capacity of single and group of piles in clay. (Apply Level)
CO3	Calculate the deflection and ultimate lateral load capacity of vertical piles. (Apply Level)
CO4	Evaluate the load carrying capacity of under reamed piles and load capacity and uplift resistance of belled piers. (Apply Level)
CO5	Calculate depth of embedment for cantilever sheet pile walls in clay and sand, Analyze the considerations for design of machine foundations. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hrs

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Shallow Foundation)

Bearing capacity of shallow foundations - IS code formula - Numerical problems - Footings subjected to moments - Numerical problems - Allowable bearing pressure from SPT N-values – Numerical problems - Footings on layered soil (concept only).

MODULE II (Settlement of Piles)
Deep foundations-- Geotechnical Design of Piles from SPT and CPT-values - Numerical problems - Settlement of pile groups in clay and sand - equivalent raft approach - Numerical problems - Settlement of pile groups in sand - Skempton's method - Meyerhof's method - Numerical problems - Uplift capacity of single piles and group of piles in clay - Numerical problems.
MODULE III (Drilled Piers and Under Reamed Piles)
Under reamed piles – Load capacity in sand and clay - design considerations as per IS code - numerical problems - Drilled piers (straight shafted and belled) in clay - Design Considerations - Load Transfer Mechanism - Vertical Bearing Capacity and uplift capacity of belled pier - Numerical problems.
MODULE IV (Piles Subjected to Lateral Load)
Behavior of vertical piles under lateral loading, Pile resistance and deflection under lateral loads, IS and Brom's method numerical problems, IS lateral load test on vertical piles - numerical problems.
MODULE V (Sheet Pile Walls and Machine Foundation)
Sheet pile walls - Types of sheet pile structures - Design of cantilever Sheet pile wall in clay and sand - Numerical problems - Anchored bulk heads – fixed earth and free earth support (concept only). Machine foundations - Types of Machine foundations, basic definitions, degree of freedom of a block foundation, general criteria for design of machine foundation, free and forced vibrations, vibration analysis of a machine foundation, determination of natural frequency, vibration isolation and control.
Text books 1. IS 6403: Code of Practice for Determination of Bearing Capacity of Shallow Foundations. 2. IS 2911 Part-I, Part-II and Part-IV: Design and construction of pile foundations. 3. Swami Saran, Analysis and design of substructures, Oxford &IBH publishing Co. Pvt. Ltd. New Delhi, 2013. 4. P. C. Varghese, Foundation Engineering, PHI Learning Private Limited, M-97, 2012. 5. Das B. M., Principles of Geotechnical Engineering, Cengage India Pvt. Ltd., 2010. 6. Ranjan G. and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2002.
Reference books 1. Arora K. R., Geotechnical Engineering, Standard Publishers, 2006. 2. Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Indersley (India) Pvt. Ltd., 2013. 3. Murthy V.N.S, Geotechnical Engineering: Principles and practices of Soil Mechanics and Foundation Engineering, New York: Marcel Dekker, 2003.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36)
MODULE I (7 hours)		
1.1	Bearing capacity of shallow foundations - IS code formula.	1
1.2	Bearing capacity of shallow foundations - IS code formula - Numerical problems.	1
1.3	Bearing capacity of shallow foundations - IS code formula - Numerical problems.	1
1.4	Allowable bearing pressure from SPT N-values.	1
1.5	Allowable bearing pressure from SPT N-values – Numerical problems.	1
1.6	Footings on layered soil. (concept only)	1
1.7	Numerical problems.	1
MODULE II (8 hours)		
2.1	Geotechnical Design of Piles from SPT and CPT-values.	1
2.2	Geotechnical Design of Piles from SPT and CPT-values - Numerical problems.	1
2.3	Settlement of pile groups in clay and sand- equivalent raft approach.	1
2.4	Settlement of pile groups in clay and sand - equivalent raft approach - Numerical problems.	1
2.5	Settlement of pile groups in sand - Skempton's method - Meyerhof's method - Numerical problems.	1
2.6	Uplift capacity of single piles and group of piles in clay.	1
2.7	Uplift capacity of single piles and group of piles in clay - Numerical problems.	1
2.8	Numerical problems.	1
MODULE III (7 hours)		
3.1	Under reamed piles – Load capacity in sand and clay.	1
3.2	Design considerations as per IS code - numerical problems.	1
3.3	Drilled piers (straight shafted and belled) in clay.	1

3.4	Drilled piers (straight shafted and belled) in clay - Design Considerations - Load Transfer Mechanism.	1
3.5	Vertical Bearing Capacity of belled pier - Numerical problems.	1
3.6	Uplift capacity of belled pier - Numerical problems.	1
3.7	Numerical problems.	1
MODULE IV (6 hours)		
4.1	Behavior of vertical piles under lateral loading.	1
4.2	Pile resistance and deflection under lateral loads, IS numerical problems.	1
4.3	Pile resistance and deflection under lateral loads - Brom's method - numerical problems.	1
4.4	IS lateral load test on vertical piles.	1
4.5	IS lateral load test on vertical piles - numerical problems.	1
4.6	Numerical problems.	1
MODULE V (8 hours)		
5.1	Sheet pile walls - Types of sheet pile structures.	1
5.2	Design of cantilever Sheet pile wall in clay - Numerical problems.	1
5.3	Design of cantilever Sheet pile wall in sand - Numerical problems.	1
5.4	Anchored bulk heads – fixed earth and free earth support (concept only).	1
5.5	Machine foundations - Types of Machine foundations, basic definitions.	1
5.6	Degree of freedom of a block foundation, general criteria for design of machine foundation.	1
5.7	Free and forced vibrations, vibration analysis of a machine foundation.	1
5.8	Determination of natural frequency, vibration isolation and control.	1

CO Assessment Questions	
CO1	A rectangular footing of dimensions 2.5 m X 3 m in plan is founded at a depth of 1.5 m below the ground level. The load on the footing acts at an angle of 15o to the vertical and is eccentric in the direction of the width by 10 cm. The saturated unit weight of soil is 18 kN/m3 . C'=15 kN/m2 , Φ'=30o . Water table is at a depth of 2m below the ground surface. Use IS 6403-1981 recommendations to calculate the net ultimate bearing capacity. For Φ'=30o , Nc=30.14, Nq= 18.4, Nγ=22.4
CO2	A group of piles has to support a vertical axial load of 2000 kN. The piles are driven into clay and have a length of 10.5 m. The thickness of the clay stratum is 15 m. The clay is followed by a rock. The saturated unit weight of clay is19 kN/m3 and its cohesion is 25 kN/m2 . The clay is normally consolidated and has a liquid limit of 60. Its specific gravity is 2.7. The water table is at the ground surface itself. Assuming the diameter of the piles as 300 mm, design a friction pile group. A factor of safety of 3 is required against shear failure. Compute its ultimate settlement.
CO3	A steel pipe pile of 61 cm outside diameter with 2.5 cm wall thickness is driven into saturated cohesive soil to a depth of 20 m. The undrained cohesive strength of the soil is 85 kPa. Calculate the ultimate lateral resistance of the pile by Broms' method with the load applied at ground level
CO4	A single under reamed pile is installed in a soft clay deposit. The centres of the under ream is located at a depth of 15m from the ground surface. The diameters of the pile shaft and bulb are respectively 1m and 2.5m. Determine the allowable load with a factor of safety of 2.5.The undrained shear strength of the soil obtained from the vane shear test is given by the relation Cu=65+7D where Cu is in kN/m2 and D is the depth in metres. Assume α=1
CO5	A cantilever sheet pile is to be installed in cohesion less soil of unit weight 20kN/m3 and φ = 30°. The height above dredge level is 6 m and water level above dredge level is 3 m. Estimate the depth of penetration needed for the sheet pile for stability. Find also the theoretical maximum bending moment in the pile

24CEE763	INTEGRATED WASTE MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course intends to impart knowledge of Integrated solid waste management aspects within the broad area of Solid waste management. A major focus of this course will be the role of MSW management within the various initiatives of the Govt. of India including Swachh Bharat Mission, Smart cities, and Make in India. At the end of this course, the student will be able to classify waste, explain the management systems, calculate various design parameters and consider various factors that contribute to the success of an integrated waste management system for a town or city.

Prerequisite: Nil

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

CO1	Describe current issues in solid waste, its management, and status in selected cities. (Understand Level)
CO2	Calculate parameters for the design of municipal solid waste management system. (Understand and Apply Level)
CO3	Explain the management of C&D and electronic waste with respect to management rules prescribed by governing bodies. (Understand Level)
CO4	Describe the management of biomedical and hazardous waste with respect to management rules prescribed by governing bodies. (Understand Level)
CO5	Describe the development of an ISWM plan. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	-	3	2	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	1	-	-	-	-	3	1	-	-	-	-	-
CO4	1	-	-	-	-	3	1	-	-	-	-	-
CO5	1	-	-	-	2	3	1	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Introduction to Solid Waste Management)

History of solid waste, 3 R's - Reduce, reuse, recycle, Waste hierarchy, Elements of Waste management systems, Present Global Scenario and Threats from Improper Waste Management, Integrated Waste Management - Source Reduction, Recycling and Waste to Energy, Landfilling.

MODULE II (Municipal Solid Waste Characteristics)

Characterization of MSW, Density and Moisture content, Elemental composition, combustible characteristics, Porosity and average of waste stream properties, Measurement of waste composition and biodegradability characterization of waste, Thermal properties and chemical composition of MSW, Method detection limit, Overview of analytical instruments, Statistical data methods.

Waste management rules, MSW Rules 2016, Swachh Bharat Mission and Smart Cities Program, Municipal Solid Waste Collection, Transportation, Segregation and

Processing, Disposal of Municipal Solid Waste: Landfill, Biochemical Processes and Composting, Energy Recovery from Municipal Solid Waste, Current Issues in Solid Waste Management and Review of MSW Management Status in selected Smart Cities in the Country.

MODULE III (C&D and E-Waste)

Construction and Demolition (C&D) Waste Management – Overview.

C&D Waste – Components, Methods of recycling and managing C&D waste streams, Beneficial Reuse of C&D Waste Materials; Construction and Demolition Waste Management Rules 2016 and challenges, Disaster Debris case study of Hurricane Katrina.

Electronic Waste (E-Waste) Management – Definition, Categories, Facts and figures from Indian context, Environmental and health hazards, e-waste recycling - Status and case study in India, e-waste characterization, generation rates, disposal of e-waste.

E-Waste Management Rules 2016 and Management Challenges.

MODULE IV (Hazardous and Biomedical Waste)

Biomedical waste - Types of waste, Segregation, packaging, transportation and storage, Treatment and disposal methods, Biomedical waste management rules 2016 and challenges.

Hazardous waste - Types and Processes generating hazardous wastes; Characteristics of hazardous waste, Hazardous waste management rules 2016 and challenges.

MODULE V (Integrated Waste Management and Life Cycle Assessment)

Developing ISWM (Integrated solid waste management) plan - Strategic planning process, situation analysis, Drivers for ISWM plan, how to structure the ISWM plan; Monitoring, Evaluation and Continuous improvement.

Life Cycle Assessment – Methodology and ISO Framework.

Text books

1. William A. Worrell and P. Aarne Veslind, “Solid Waste Engineering”, 2nd Edition Cengage Learning, 2012. (ISBN-13: 978-1-4390-6217-3)
2. George Tchobanoglous, Hilary Theisen and Samuel A Vigil, “Integrated Solid Waste Management”, Tata McGraw Hill, 1993.

Reference Books

1. “Municipal Solid Waste Management Rules 2016”, Central Pollution Control Board, Govt. of India, 2016.
2. “Electronic Waste Management Rules 2016”, Central Pollution Control Board, Govt. of India, 2016.
3. “Construction and Demolition Waste Management Rules 2016”, Ministry of Environment and Forest and Climate Change, Govt. of India, 2016.
4. “Bio-Medical Waste Management Rules, 2016”, Ministry of Environment and Forest and Climate Change, Govt. of India, 2016.
5. The Central Public Health and Environmental Engineering Organization (CPHEEO) “Manual on Solid Waste Management”, India, 2016.

6. United Nations Environmental Programme, "Developing Integrated Solid waste management Plan, Training manual, Vol.4, 2009.
7. ISO 14044:2006 Environmental Management, Lifecycle Assessment-Requirements and guidelines.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (6 Hours)	
1.1	History of solid waste,3 R's - Reduce, reuse, recycle, Waste hierarchy, Elements of Waste management systems.	1
1.2	Present Global Scenario and Threats from Improper Waste Management, Integrated Waste Management - Source Reduction, Recycling and Waste to Energy.	1
1.3	Landfilling - Modern v/s traditional landfill (LF), Overview of types of landfill, regulatory requirements for LF, liners, leachate and gas collection system, treatment and storage facility, LF stabilization, Problems associated with landfill gas.	1
1.4	Waste management rules, MSW Rules 2016, Overview and duties of different stakeholders, Organizational structure for a smart city, areas of application, waste generators. Duties of Ministry of Environment, Forest and climate change (MoEFCC) and other central committees.	1
1.5	Swachh Bharat Mission and Smart Cities Program, Storage of solid waste - Different types of storage containers and its use.	1
1.6	Current Issues in Solid Waste Management and Review of MSW Management Status in selected Smart Cities in the Country.	1
	MODULE II (9 Hours)	
2.1	Characterization of MSW, Density and Moisture content, Elemental composition, combustible characteristics, Porosity and average of waste stream properties.	1
2.2	Measurement of waste composition and biodegradability characterization of waste, Thermal properties and chemical composition of MSW.	1
2.3	Method detection limit, Overview of analytical instruments, Statistical data methods.	1
2.4	Municipal Solid Waste Collection, equipment types and different collection systems.	1
2.5	Funding and payment for collection, MSW generation rate calculation.	1
2.6	Transportation of MSW, Segregation of MSW.	1

2.7	Segregation, Processing of MSW.	1
2.8	Disposal of Municipal Solid Waste: Landfill, Biochemical Processes and Composting.	1
2.9	Energy Recovery from Municipal Solid Waste.	1
MODULE III (9 Hours)		
3.1	Construction and Demolition (C&D) Waste Management – Overview of C&D Waste – Regulation, Components, Methods of recycling.	1
3.2	Managing C&D waste streams, Beneficial Reuse of C&D Waste Materials.	1
3.3	Construction and Demolition Waste Management Rules 2016 and challenges.	1
3.4	Disaster Debris case study of Hurricane Katrina.	1
3.5	Electronic Waste (E-Waste) Management – Definition, Categories, Facts and figures from Indian context.	1
3.6	Environmental and health hazards, e-waste recycling - Status and case study in India.	1
3.7	e-waste characterization, generation rates, Tests on WEEE. (Waste from Electrical and Electronic equipment)	1
3.8	Tests on WEEE (Waste from Electrical and Electronic equipment), disposal of e-waste.	1
3.9	E-Waste Management Rules 2016 and Management Challenges.	1
MODULE IV (6 Hours)		
4.1	Biomedical waste - Types of waste, Segregation.	1
4.2	Packaging, transportation and storage, Treatment and disposal methods.	1
4.3	Biomedical waste management rules 2016 and challenges.	1
4.4	Hazardous waste - Types and Processes generating hazardous wastes; Characteristics of hazardous waste.	1
4.5	TCLP (Toxicity Characteristic Leaching Procedure test), Limits of TCLP concentration and its basis.	1
4.6	Hazardous waste management rules 2016 and challenges.	1
MODULE V (6 Hours)		
5.1	Developing ISWM (Integrated solid waste management) plan - Strategic planning process, situation analysis.	1
5.2	Drivers for ISWM plan, How to structure the ISWM plan.	1
5.3	Monitoring, Evaluation and Continuous improvement.	1
5.4	Life Cycle Assessment (LCA) – Methodology and ISO Framework.	1
5.5	Life Cycle Inventory and Impact Assessments.	1

5.6	Factors for Good LCA Study.	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>CO 1</td><td>1. Elaborate the elements of Waste management systems.
2. Discuss the status of waste management in any four Indian cities.</td></tr>
<tr><td>CO 2</td><td>1. You are mixing two waste streams together; they have the following characteristics:
<table>
<tr><th>Waste</th><th>% Total Mass</th><th>Density (kg/m3)</th><th>Moisture Content (%)</th><th>Cadmium (mg/kg-wet)</th></tr>
<tr><td>A</td><td>55</td><td>1120</td><td>50</td><td>370</td></tr>
<tr><td>B</td><td>45</td><td>800</td><td>30</td><td>120</td></tr>
</table>
Determine the density and moisture content of the mixed material.
2. A waste storage container needs to be installed near an established high rise building. The building has 600 apartments and average 4 occupants per apartment. The rate of waste generation is considered as 0.8 kg/person/day as the building is placed in developed locality of urban area. Determine the volume of container (in m^3) if the non-compacted waste (density 100 kg/m^3) from container will be hauled in 7 trips per week.
3. An environmental laboratory was evaluating a mixture of 2 kg of yard waste (C: N = 15:1) for possible feed of a compost plant. If the mixture is having a moisture content of 60%, what conclusion the laboratory analyst should draw?</td></tr>
<tr><td>CO 3</td><td>1. Discuss the major learnings from Hurricane Katrina to deal with disaster debris in future.
2. Explain the responsibilities of the governmental agencies to implement e-waste management systems according to E-waste management rules of 2022.</td></tr>
<tr><td>CO 4</td><td>1. Elaborate the segregation, packaging, transportation and storage procedures to be adopted for biomedical wastes.
2. Discuss the parameters that describe a waste as hazardous.</td></tr>
<tr><td>CO 5</td><td>1. Explain the various features of ISWM.
2. Discuss the role of stakeholders in Integrated waste management</td></tr>
</table>

24CEE773	APPLIED HYDROLOGY	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course aims to equip students with comprehensive knowledge in surface water hydrology and groundwater hydrology. The goal is to impart proficiency in analyzing hydrological data, applying various models and methods to comprehend and predict water-related phenomena, ultimately enabling effective water resource management and environmental conservation. By the end of this course, students will demonstrate competence in interpreting hydrological data, employing relevant techniques for watershed assessment, and proposing solutions for sustainable water resource utilization and management.

Prerequisite: 24CET501 Hydrology and Water Resources Engineering

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

CO1	Describe and estimate the different components of hydrologic cycle by processing hydro-meteorological data. (Apply Level)
CO2	Explain the behavior of catchments and quantify the response of the catchment. (Understand and Apply Level)
CO3	Apply the concept of hydrograph for runoff computation. (Apply Level)
CO4	Apply hydrological and statistical principles for estimation of flood discharge. (Apply Level)
CO5	Determine the aquifer parameters and assess the groundwater potential and quality. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test 1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Rainfall and Abstractions)

Hydrology and Hydrologic cycle (Review) Test for consistency of rainfall records – Double mass curve method. Analysis of rainfall data – intensity, duration, frequency (IDF) curves; depth area duration (DAD) curve. Hydrologic abstractions – Infiltration - Green Ampt method - Evapotranspiration - methods of estimation - Blaney Criddle method - Penman method, Penmann-Montieth method.

MODULE II (Catchment and Streamflow)

Catchment characteristics, classification of streams - stream pattern and stream order; Stream gauging – methods - rating of current meter; Extension of stage discharge curve, Adjustment of stage discharge curve; selection of site for stream gauging stations.

MODULE III (Runoff)
Runoff - Computation of runoff – Popular Hydrological models, Hydrograph analysis – S-hydrograph, unit hydrograph from complex storm, synthetic unit hydrograph, Instantaneous unit hydrograph (Brief description only), linear reservoir model. Application of linear regression in hydrologic modeling.
MODULE IV (Flood)
Design flood and their Estimation - Different methods; Flood frequency studies - Gumbel's method; Flood routing - Hydrologic and Hydraulic routing, Flood routing through reservoirs – concept only. Flood routing through channels - Muskingum method. Flood control methods - Flood forecasting and warning (Brief descriptions only).
MODULE V (Groundwater Hydrology)
Partial differential equation governing unsteady groundwater flow - Evaluation of aquifer parameters - Theis method - Jacob's approximation method. Well flow near aquifer boundaries - Method of images, Surface investigation of groundwater - Electrical resistivity method. Graphical representation of hydrochemical data, Pollution of groundwater - sources; Seawater intrusion - Ghyben-Herzberg relationship, Method of control of seawater intrusion; Artificial recharge of groundwater.
Text books 1. Raghunath H. M. Hydrology: Principles, Analysis and Design. New Age International New Delhi 2006. 2. VenTe Chow. Hand book of Applied Hydrology, Tata McGraw Hill, 1988. 3. Subramanya K. Engineering Hydrology, Tata McGraw Hill, 2013. 4. Reddy J. R., A text book of Hydrology, Laxmi Publishers, 2016
Reference books 1. Ojha C. S. P, R. Berndtsson, P. Bhunya, Engineering Hydrology, Oxford University Press. 2. Todd D. K. Ground Water Hydrology, Wiley, 2005. 3. H.M Raghunath. Groundwater. New Age International New Delhi 2007. 4. Garg S. K. Hydrology and Water Resources Engineering, Khanna Publishers New Delhi 2005. 5. Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L. Pande, Irrigation and Water Power Engineering, Laxmi Publications (P) Ltd. 2009.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36)
MODULE I (7 Hours)		
1.1	Hydrology and Hydrologic cycle.	1

1.2	Test for consistency of rainfall data – Double Mass Curve technique.	1
1.3	Analysis of rainfall data intensity, duration, frequency (IDF) curves and use.	1
1.4	Graphical representations- Depth area duration (DAD) curve.	1
1.5	Hydrologic abstractions- Infiltration- Green Ampt method.	1
1.6	Evapotranspiration- methods of estimation- Blaney Criddle method.	1
1.7	Penman method, Penmann-Montieth method.	1
MODULE II (7 Hours)		
2.1	Catchment Characteristics.	1
2.2	Classification of streams – Stream pattern and stream order.	1
2.3	Stream gauging- different methods.	1
2.4	Selection of site for stream gauging stations.	1
2.5	Stage Discharge Curve.	1
2.6	Extension of stage discharge curve.	1
2.7	Adjustment of stage discharge curve.	1
MODULE III (7 Hours)		
3.1	Runoff - Computation of runoff, Popular Hydrological models.	1
3.2	Hydrograph analysis and S- Hydrograph.	1
3.3	Unit hydrograph from complex storm.	1
3.4	Synthetic unit hydrograph.	1
3.5	Instantaneous unit hydrograph, Linear reservoir model.	1
3.6	Numerical examples from hydrograph analysis.	1
3.7	Application of linear regression in hydrologic modeling.	1
MODULE IV (7 Hours)		

4.1	Design flood and their Estimation - Different methods.	1
4.2	Flood frequency studies - Gumbel's method.	1
4.3	Flood routing-Hydrologic and Hydraulic routing.	1
4.4	Flood routing through reservoirs – concept and approaches.	1
4.5	Flood routing through channels - Muskingum method.	1
4.6	Problems solving on flood routing.	1
4.7	Flood control methods, Flood forecasting and warning.	1
MODULE V (6 Hours)		
5.1	Partial differential equation governing unsteady groundwater flow; Evaluation of aquifer parameters - Theis method.	1
5.2	Jacob's approximation method.	1
5.3	Well flow near aquifer boundaries - Method of images.	1
5.4	Surface investigation of groundwater - Electrical resistivity method.	1
5.5	Graphical representation of hydrochemical data, Pollution of Groundwater - sources.	1
5.6	Seawater intrusion - Ghyben-Herzberg relationship, Method of control of seawater intrusion; Artificial recharge of groundwater.	1

CO Assessment Questions

CO1

1. The annual rainfall data of a station A and the annual rainfall values of 6 neighboring stations are given below. Check the consistency of rainfall record of station A, by double mass curve method.

Year	Annual rainfall of Station A (cm)	6 station average (cm)
1969	177	143
1970	144	132
1971	178	146
1972	162	147

	1973	194	161
	1974	168	155
	1975	196	152
	1976	144	117
	1977	160	128
	1978	196	193
	1979	141	156
	1980	158	164
	1981	145	155
	1982	132	143
	1983	95	115
	1984	148	135
	1985	142	163
	1986	140	135
	1987	130	143
	1988	137	130
	1989	130	146
	1990	163	161

2. Explain Green Ampt model for estimation of infiltration.

CO2	1. Three points on a rating curve of a stream gauging station obtained from an eye-fit for the stage discharge data have the following coordinates: 100 m^3/s; 121.67 m), (200 m^3/s,122.23 m) and (400 m^3/s,123.04. Determine the equation of the rating curve and compute the discharge in the stream corresponding to a stage of 124.5 m. 2. Explain (i) time of concentration (ii) drainage density (iii) form factor.
CO3	1. The effective rainfall hyetograph of a complex storm has duration of 12 h with rainfall intensity 2, 0.75 and 4 cm/h respectively in successive 4 h periods. The ordinates of the corresponding DRH read at 4 h intervals are 160, 300, 570, 636, 404, 234, 105 and 48 m^3/sec. Determine the ordinates of 4 hr unit hydrograph using the deconvolution method. 2. From the topographical map of a drainage basin, the following quantities are measured. A=3480 km^2; Length of the main stream (L) is 148 km and distance from the centroid of the basin to the catchment outlet (Lc) is 74 km. The 12 hr unit hydrograph derived for the basin has a peak ordinate of 155 m^3/s occurring at 40 hrs. Derive

<table>
<tr><td></td><td>the 4 hr synthetic unit hydrograph of sub-basin of the catchment, having drainage area 2500 km^2, L=100km and Lc=50 km using Snyder's method.</td></tr>
<tr><td>CO4</td><td>1. Flood frequency computations for a river by using Gumbel's method, yielded the following results:
<table><tr><th>Return period (T)(Years)</th><th>Peak flood (m^3/sec)</th></tr><tr><td>40</td><td>27000</td></tr><tr><td>80</td><td>31000</td></tr></table>Estimate the flood magnitude in the river with the return period of 240 years.
2. Differentiate hydraulic routing and hydrologic routing.</td></tr>
<tr><td>CO5</td><td>1. Derive partial differential equation for unsteady flow in a confined aquifer
2. In an artesian aquifer, the drawdown is 1.2 m at a radial distance of 10 m from a well after two hours of pumping. On the basis of Thies' non-equilibrium equation determine the pumping time for the same drawdown at a radial distance of 30 m from the well.</td></tr>
</table>

24CEE783	DESIGN OF HYDRAULIC STRUCTURES	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The general objective of this course is to expose the students to the fundamental concepts of hydraulic design of different hydraulic structures. This course equips the students to perform the hydraulic design of minor irrigation structures such as cross drainage works, canal falls and regulators. Upon completion of this course, students will demonstrate proficiency in designing various hydraulic structures, employing critical thinking to assess stability, and applying appropriate methodologies to address potential failures, thereby contributing to safe and sustainable water resource infrastructure.

Prerequisite: 24CEP403 Fluid Mechanics, 24CET501 Hydrology and Water Resources Engineering, 24CEE654 Open Channel Hydraulics

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

CO1	Explain the causes of failure and design principles of impervious floor of hydraulic structures. (Understand and Apply Level)
CO2	Describe the design principles or features of canal structures. (Understand Level)
CO3	Perform the hydraulic design of canals and canal structures. (Apply Level)
CO4	Describe the design principles of dams or perform the stability analysis of gravity dams. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse		✓		
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test 1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Canal Structures)

Weirs – types and causes of failure - Design of Impervious floor of hydraulic structures – Bligh's theory, Design of vertical drop weir; Design of impervious floor of hydraulic structures by Khosla's theory - stability check for weirs.

MODULE II (Canal Structures)

Design of canals through alluvial soils - Kennedy's theory and Lacey's silt theory. Design of Erodible channels which scour but do not silt - Tractive force approach.
Canal structures - cross drainage structures types - Hydraulic design of Aqueduct; Siphon Aqueduct.

MODULE III (Canal Structures)

Canal falls – types; Hydraulic design of Canal drop (Trapezoidal Notch Fall); Cross and head regulators (impervious floor design using Khosla's theory).

MODULE IV (Gravity Dams)
Gravity Dams - computation of forces - modes of failure and stability criteria, stability analysis. Elementary and practical profile, limiting height of gravity dams.
MODULE V (Earth dams, Arch Dams and Spillways)
Earth dams - types, causes of failure and design criteria, Arch dams - thin cylinder theory; Spillways – types - Ogee spillway profile; Energy dissipation - stilling basins - Indian standard Type I and Type II (description only).

Text books

1. Sathyanarayana M. C. Water Resources Engineering - Principles and Practice, New Age International Publishers. 2009.
2. Garg S. K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers, New Delhi 2006.
3. Arora K. R. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors, New Delhi, 2010.

Reference books

1. Punmia B. C. Ashok K. Jain, Arun K. Jain, B. B. L. Pande, Irrigation and Water Power Engineering, Laxmi Publications Pvt. Ltd., 2009.
2. Modi P. N. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors, New Delhi, 2009.
3. Varshney R. S. Theory & Design of Irrigation Structures - Vol III, Nem Chand & Bros., Roorkee.2009

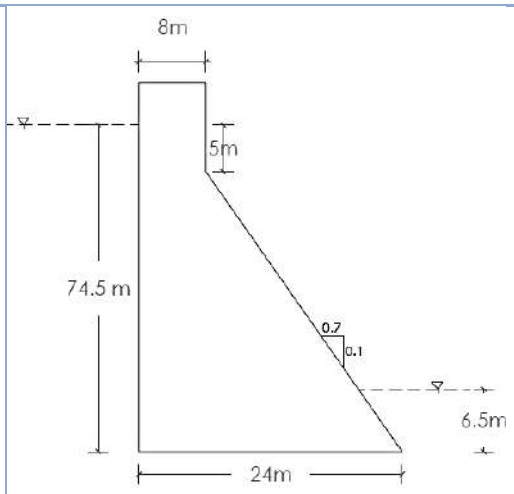
COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (9 hours)	
1.1	Weirs – types and causes of failure.	1
1.2	Design of Impervious floor of hydraulic structures – Bligh's theory.	1
1.3	Perform the design of impervious floor using Bligh's theory.	1
1.4	Design of vertical drop weir.	1
1.5	Design of vertical drop weir.	1
1.6	Design of impervious floor of hydraulic structures by Khosla's theory.	1
1.7	Khosla's method of independent variables.	1
1.8	Perform the stability check of weir profiles using Khosla's theory.	1
1.9	Perform the stability check of weir profiles using Khosla's theory.	1

MODULE II (10 hours)		
2.1	Design of canals through alluvial soils - Kennedy's theory.	1
2.2	Design of canals through alluvial soils - Lacey's silt theory.	1
2.3	Erodable channels - tractive force approach.	1
2.4	Types and features of cross drainage structures.	1
2.5	Hydraulic design of Aqueduct.	1
2.6	Hydraulic design of Aqueduct.	1
2.7	Hydraulic design of Aqueduct.	1
2.8	Hydraulic design of Siphon Aqueduct.	1
2.9	Hydraulic design of Siphon Aqueduct.	1
2.10	Hydraulic design of Siphon Aqueduct.	1
MODULE III (6 hours)		
3.1	Types and features of canal falls.	1
3.2	Hydraulic design of Canal drop (Trapezoidal Notch Fall).	1
3.3	Hydraulic design of Canal drop (Trapezoidal Notch Fall).	1
3.4	Design of Cross regulator (impervious floor design using Khosla's theory).	1
3.5	Design of Cross regulator (impervious floor design using Khosla's theory).	1
3.6	Design of Cross regulator (impervious floor design using Khosla's theory.)	1
MODULE IV (6 hours)		
4.1	Gravity Dams - computation of forces.	1
4.2	Modes of failure and stability criteria of Gravity dams.	1
4.3	Stability analysis of Gravity dams.	1

4.4	Stability analysis of Gravity dams-Numerical example.	1
4.5	Elementary and practical profile of gravity dams.	1
4.6	Limiting height of gravity dams.	1
MODULE V (5 hours)		
5.1	Earth dams - types and components.	1
5.2	Causes of failure of earth dams, design criteria.	1
5.3	Arch dams - types, thin cylinder theory - Central angle.	1
5.4	Spillways - function and types; Ogee spillway profile and design criteria.	1
5.5	Energy dissipation below spillways - stilling basins - Indian standard Type I and Type II (description only).	1

CO Assessment Questions	
CO1	1. Explain Bligh's theory. 2. Explain Khosla's corrections. 3. An impervious floor of a weir on permeable soil is 16 m long and has sheet piles at both the ends. The upstream pile is 4 m deep and the downstream pile is 5 m deep. The weir creates a net head of 2.5 m. Neglecting the thickness of weir floor, calculate the uplift pressures at the junction of the inner faces of the upstream pile with the weir floor, by using Khosla's theory.
CO2	1. Describe the features of different types of canal falls. 2. Explain tractive force approach for the design of erodible channel.
CO3	1. Compute the uplift pressure on the barrel floor of siphon aqueduct for the following data Length of contraction transition: 18 m; Width of the barrel: 9 m; height of the barrel: 2.5 m; Canal bed level: 200.00; Bed level of the drain: 198.00; Full supply level: 201.8; Thickness of barrel roof slab: 0.5 m; Thickness of floor: 0.8 m; length of the floor: 27.8 m. 2. Design the notch of a 2 m canal drop for the following data: Full supply discharge= 5 .00cumec; Bed width= 6.00 m; Full supply depth=1.5 m.
CO4	1. Determine the minimum and maximum vertical stress at heel and toe, major principal stress at toe and intensity of shear stress on a horizontal plane near the toe of the dam. Weight of concrete = 23.5 kN/m^3, Allowable stress in concrete = 2500 kN/m^2.



2. Explain thin cylinder theory for the design of arch dams.
3. Explain limiting height of gravity dam.

24CEE793	ADVANCED ENVIRONMENTAL ENGINEERING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to become familiar with the advanced treatment systems for water and wastewater and to make them capable to design a complete water treatment plant and wastewater treatment plant. This course covers treatment techniques for water and wastewater treatment, suitable sludge management techniques and predicts the self-purification capacity of streams under varying environmental conditions. Students will be equipped to recommend suitable sludge treatment and disposal methods.

Prerequisite: 24CET503 Environmental Engineering

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

CO1	Explain various advanced water treatment techniques. (Understand and Apply Level)
CO2	Describe the aerobic techniques for waste water treatment. (Understand and Apply Level)
CO3	Explain various anaerobic techniques for waste water treatment. (Understand and Apply Level)
CO4	Discuss the self-purification capacity of streams. (Understand and Apply Level)
CO5	Recommend suitable sludge management techniques. (Understand and Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	2	3	-	-	-	-	-
CO2	2	3	-	-	-	2	3	-	-	-	-	-
CO3	2	2	-	-	-	2	3	-	-	-	-	-
CO4	3	2	-	-	-	3	2	-	-	-	-	-
CO5	3	-	-	-	-	3	2	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hrs

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Advanced Water Treatment)

Advanced water treatment: adsorption – types, various adsorbents, adsorption isotherm and kinetics, breakthrough curve and design of adsorption column, Principle and working of ion exchange process; principle of electrodialysis; fluoridation and defluoridation methods; principle of reverse osmosis, ultrafiltration, microfiltration and nanofiltration.

MODULE II (Advanced Wastewater Treatment)

Advanced wastewater treatment: Aerobic systems - Principle and working of aerobic systems – sequencing batch reactor (including design), rotating biological contactor, fixed bed biofilm activated sludge process, moving bed biofilm reactor (including design), membrane bioreactor, advanced oxidation process; Nature-based treatment systems – oxidation ponds (including design), artificial wetlands, phytroid technology,

RENEU systems.

MODULE III (Advanced Wastewater Treatment)

Advanced wastewater treatment: Anaerobic systems - principle and working of high rate anaerobic systems – upflow anaerobic sludge blanket reactor (including design), anaerobic fixed film reactor, fluidized bed reactor, anaerobic filters; decentralized wastewater treatment systems. (concepts only)

MODULE IV (Disposal of Sewage)

Disposal of sewage: disposal into water bodies – effluent standards by CPCB, surface water quality standards and best designated use (IS 2296); First stage BOD formulation; self-purification of streams – pollution zones, oxygen sag curve analysis, Streeter Phelp's equation; disposal into land for irrigation – methods, CPCB standards of irrigation water, sewage sickness.

MODULE V (Sludge Management)

Sludge management: characteristics of sludge, processing methods – thickening, digestion – stages of anaerobic digestion, influencing factors, design of sludge digestion tank; sludge drying bed; sludge disposal methods, recycling of digested sludge. Application of SCADA for treatment plants, Field visits to treatment plants and preparation of report. (For internal evaluation only)

xt books

1. Howard S Peavy, Donald R Rowe and George Tchobanoglous, Environmental Engineering, Mc Graw Hill Education, 2013.
2. Mackenzie L Davis, David A Cornwell, Introduction to Environmental Engineering, Mc Graw Hill Education, 2014.
3. Gilbert M Masters, Introduction to Environmental Engineering and Science, Pearson Education India; 3rd edition, 2015.
4. J. Arceivala, Shyam R. Asolekar, Wastewater Treatment for Pollution Control and Reuse, McGrawhill Education, 2007.
5. S.K. Garg, Sewage disposal and air pollution engineering, Khanna Publishers, 2008.

Reference books

1. Metcalf and Eddy, Waste Water Engineering, Tata McGraw Hill publishing Co Ltd, 2003.
2. Syed R Qasim, Wastewater Treatment Plants-Planning, Design & Operation, CRC Press,1999.
3. Baker, Membrane Technology and Applications, 3rd ed., Wiley-Blackwell 2012.
4. Fane, Schaefer, Waite, Nanofiltration, Principles and applications, Elsevier 2004.
5. Peinemann, Nunez, Membrane Technology, 6 vols, Wiley-VCH 2007 – 2010.
6. Manual on water supply and treatment, Central Public Health and Environmental Engineering Organization, Ministry of Urban Affairs, GoI, 1999.
7. Manual on sewerage and sewage treatment, Central Public Health and Environmental Engineering Organization, Ministry of Urban Affairs, GoI, 2013.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
MODULE I (9 hours)		
1.1	Adsorption – types, various adsorbents.	1
1.2	Adsorption isotherm.	1
1.3	Adsorption kinetics.	1
1.4	Breakthrough curve and design of adsorption column.	1
1.5	Principle and working of ion exchange process.	1
1.6	Principle of electrodialysis.	1
1.7	Fluoridation and defluoridation methods.	1
1.8	Principle of reverse osmosis, ultrafiltration.	1
1.9	Microfiltration and nanofiltration.	1
MODULE II (9 hours)		
2.1	Aerobic systems - Principle and working of aerobic systems.	1
2.2	Sequencing batch reactor. (including design)	1
2.3	Rotating biological contactor.	1
2.4	Fixed bed biofilm activated sludge process.	1
2.5	Moving bed biofilm reactor. (including design)	1
2.6	Membrane bioreactor.	1
2.7	Advanced oxidation process.	1
2.8	Nature-based treatment systems – oxidation ponds. (including design)	1
2.9	Artificial wetlands, phytroid technology- RENEU systems.	1
MODULE III (6 hours)		
3.1	Anaerobic systems - principle and working of high rate anaerobic systems.	1

3.2	Upflow anaerobic sludge blanket reactor. (including design)	1
3.3	Anaerobic fixed film reactor.	1
3.4	Fluidized bed reactor.	1
3.5	Anaerobic filters.	1
3.6	Decentralized wastewater treatment systems. (concepts only)	1
MODULE IV (6 Hours)		
4.1	Disposal of sewage: disposal into water bodies – effluent standards by CPCB.	1
4.2	Surface water quality standards and best designated use (IS 2296); First stage BOD formulation;	1
4.3	Self purification of streams – pollution zones.	1
4.4	Oxygen sag curve analysis, Streeter Phelp's equation;	1
4.5	Disposal into land for irrigation – methods.	1
4.6	CPCB standards of irrigation water, sewage sickness.	1
MODULE V (6 Hours)		
5.1	Sludge management: characteristics of sludge.	1
5.2	Processing methods – thickening.	1
5.3	Digestion – stages of anaerobic digestion, influencing factors.	1
5.4	Design of sludge digestion tank; sludge drying bed;	1
5.5	Sludge disposal methods, recycling of digested sludge.	1
5.6	Application of SCADA for treatment plants, Field visits to treatment plants and preparation of report. (For internal evaluation only)	1

CO Assessment Questions	
CO1	Explain breakthrough curve in continuous adsorption process.

CO2	a) How biological process in RBC is different from that in MBBR? b) Design a sequential bio reactor process to treat a domestic waste water with a flow of 7570 m3/day. Design conditions and assumptions. Use 2 tanks, total liquid depth when full is 6m, decant depth = 30% of the tank depth, SVI = 150mL/g.
CO3	a) Explain the principle and working of a UASB Reactor. b) Design a UASB for treating 3.5 MLD of sewage having a COD of 650 mg/L. Make suitable assumptions
CO4	A city discharges 25 million gallons per day (mgd) of domestic sewage into a stream with a typical flow rate of 250 cubic feet per second (cfs). The velocity of the stream is approximately 3 miles per hour. The temperature of the sewage is 21 °C, while that of the stream is 15 °C. The 20 °C BOD5 of the sewage is 180 mg/L, while that of the stream is 1.0 mg/L. The sewage contains no dissolved oxygen, but the stream is 90 percent saturated upstream of the discharge. At 20 °C, k' is estimated to be 0.34 per day while k'2 is 0.65 per day. (1) Determine the critical-oxygen deficit and its location. (2) Also estimate the 20 °C BOD5 of a sample taken at the critical point. Use temperature coefficients of 1.135 for k' and 1.024 for k'2. (3) Plot the dissolved-oxygen-sag curve. (4) Determine the dissolved oxygen concentration at 1000 km from the point source.
CO5	a) Discuss the different methods of sludge digestion. b) Design a sludge digestion tank with following data. Average flow of sewage = 60MLD, Total suspended solids concentration = 350 mg/l, Volatile suspended solids concentration = 250mg/l, Moisture content of the digested sludge = 87%, Assume 65% of the removal done in primary settling tank. Fresh sewage has a water content of 95%.

24CEE7103	TRANSPORTATION PLANNING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course aims to provide students with fundamental understanding of the principles, theories and various stages in transportation planning process. This course covers a wide range of topics related to transportation planning including issues and challenges in transportation planning, various data collection techniques, four stage planning process and about various land use models. After the completion of the course, the students will be able to have a comprehensive understanding of transportation planning - significance, challenges, and its synergy with urban structure, along with the ability to apply critical planning concepts and tools.

Prerequisite: Nil

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Identify the need for transportation planning, the issues and challenges related to transportation and its interaction with urban structure and land use. (Understand Level)
CO2	Express the significance of travel demand in the context of transportation planning, and demonstrate the application of this concept within the framework of a systems approach to the transportation planning process. (Understand Level)
CO3	Demonstrate the concepts of study area delineation, data sampling, and data collection techniques in the four-stage planning process, and use these methods to predict trip generation. (Apply Level)
CO4	Illustrate different methods for predicting trip distribution, mode split, and traffic assignment within the context of the four-stage planning process in transportation planning. (Apply Level)
CO5	Infer the application of land use transport models, sustainable transportation planning approaches, and the use of GIS in crafting a comprehensive mobility plan. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	-	-	-	-	-	-	-	-
CO2	1	1	-	-	-	-	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-	-	-	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓

Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

Module I (Transportation Planning, Urban Structure, and Land Use Integration)

Need for transportation planning - Characteristics of urban travel, Transportation issues and challenges.

Urban Structure - types and properties - centripetal, grid, linear, directional, Movement and Accessibility – Hierarchy of transportation facilities.

Transportation and land use - Role of urban activity analysis in transportation planning, Transportation impacts on activity system, Land use transportation interaction.

Module II (Demand Analysis and Transportation Planning Processes)

Role of demand analysis in transportation planning - Classification of urban transport demand and factors affecting demand, modelling based on consumer behavior of travel choices, Basic principles of travel demand analysis and assumptions.

Transportation planning process - Systems approach, Elements/stages of transportation planning process - Goal, objectives and constraints, Trip-based and Activity-based approaches for transportation planning.

Module III (Data Collection, Zoning, and Trip Generation)

Data collection – Definition of study area, zoning - selection of cordon, Sampling techniques and sample size, Sources of data and types of surveys for planning.

Trip Generation - Factors influencing trip generation, methods of forecasting trip generation rates - linear regression (problems), category analysis. (concept only)

Module IV (Four Stage Planning Process)

Trip Distribution - Growth factor methods - Uniform factor method, Average factor method (problems), Fratar Method and Furness Method (concept only) - Synthetic methods - Gravity models, opportunity model. (Concept only)

Modal Split - Factors influencing modal split, Types of mode split models – trip end, trip interchange - Logit model. (concept only)

Traffic assignment - Purpose, Elements of transportation networks - Nodes and links, Methods for traffic assignment - All or Nothing Assignment, Multiple path Assignment, Capacity Restraint Assignment, Diversion curves. (Concept only)

Module V (Holistic Approach to Urban Mobility Solutions)

Land use models - Selection of land use model, Lowry model - Structure, features, Model equation system.

Sustainable transportation - features, facilities, Transit oriented development, Non transport solutions to transport problems, Transportation demand management.

Comprehensive Mobility Plan - objectives and activities involved, Application of GIS in transport planning.

Text Books:

1. Bruton, M. J. (2021). Introduction to transportation planning (Vol. 5). Routledge.
2. Hutchinson, B. G. (1974). Principles of urban transport systems planning. Scripta Book Company.
3. Kadiyali, L. R. (2013). Traffic engineering and transport planning. Khanna publishers.

Reference Books:

1. Dickey, J. W. (2018). Metropolitan transportation planning. Routledge.
2. Khisty, C. J., & Lall, B. K. (2016). Transportation engineering. Pearson Education India.
3. Papacostas, C. S., & Prevedouros, P. D. (1993). Transportation engineering and planning. Pearson.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36)
Module I (6 Hours)		
1.1	Need for transportation planning - Characteristics of urban travel, Transportation issues and challenges.	1
1.2	Urban Structure - types and properties – centripetal, grid, linear.	1
1.3	Directional, Movement and Accessibility – Hierarchy of transportation facilities.	1
1.4	Directional, Movement and Accessibility – Hierarchy of transportation facilities.	1
1.5	Transportation and land use – Role of urban activity analysis in transportation planning.	1
1.6	Transportation impacts on activity system, Land use transportation interaction.	1
Module II (6 Hours)		
2.1	Role of demand analysis in transportation planning - Classification of urban transport demand and factors affecting demand.	1
2.2	Modelling based on consumer behavior of travel choices, Basic principles of travel demand analysis and assumptions.	1
2.3	Transportation planning process – Systems approach.	1
2.4	Elements/stages of transportation planning process – Goal, objectives and constraints.	1
2.5	Trip-based and Activity-based approaches for transportation planning.	1
2.6	Trip-based and Activity-based approaches for transportation planning.	1
Module III (8 Hours)		
3.1	Data collection – Definition of study area, zoning - selection of cordon.	1

3.2	Sampling techniques and sample size.	1
3.3	Sources of data and types of surveys for planning.	1
3.4	Trip Generation - Factors influencing trip generation, methods of forecasting trip generation rates.	1
3.5	Trip Generation - Factors influencing trip generation, methods of forecasting trip generation rates.	1
3.6	Linear regression. (problems)	1
3.7	Linear regression. (problems)	1
3.8	Category analysis. (concept only)	1
Module IV (9 Hours)		
4.1	Trip Distribution - Growth factor methods - Uniform factor method.	1
4.2	Average factor method (problems), Fratar Method and Furness Method (concept only)	1
4.3	Synthetic methods - Gravity models (Concept only)	1
4.4	Opportunity model. (Concept only)	1
4.5	Modal Split - Factors influencing modal split, Types of mode split models.	1
4.6	Trip end, trip interchange - Logit model (concept only)	1
4.7	Traffic assignment - Purpose, Elements of transportation networks - Nodes and links.	1
4.8	Methods for traffic assignment - All or Nothing Assignment (concept only)	1
4.9	Multiple path Assignment, Capacity Restraint Assignment, Diversion curves (Concept only)	1
Module V (7 Hours)		
5.1	Land use models - Selection of land use model.	1
5.2	Lowry model - Structure, features, Model equation system.	1
5.3	Sustainable transportation - features, facilities, Transit oriented development.	1
5.4	Non transport solutions to transport problems.	1
5.5	Transportation demand management.	1
5.6	Comprehensive Mobility Plan - objectives and activities involved.	1
5.7	Application of GIS in transport planning.	1

<table>
<tr><th colspan="2">CO Assessment Questions</th></tr>
<tr><td>CO1</td><td>Explain the issues and challenges associated with transportation.</td></tr>
<tr><td>CO2</td><td>Discuss factors affecting travel demand.</td></tr>
<tr><td>CO3</td><td>The trip rate and the corresponding household sizes from a sample are shown in table below. Compute the trip rate for the household size 3.5, using regression.
<table>
<tr><td>House hold size</td><td>3</td><td>4</td><td>2</td><td>5</td><td>1</td><td>3</td><td>2</td></tr>
<tr><td>Trip rate per week</td><td>8</td><td>11</td><td>9</td><td>14</td><td>5</td><td>7</td><td>6</td></tr>
</table></td></tr>
<tr><td>CO4</td><td>The distribution of present trips among the zones 1, 2 and 3 are given in the OD matrix below. The future trips generated in zones 1, 2 and 3 are expected to be 360, 1260 and 3120 respectively. Distribute the future trips among the zones.
<table>
<tr><th>O/D</th><th>1</th><th>2</th><th>3</th></tr>
<tr><td>1</td><td>60</td><td>100</td><td>200</td></tr>
<tr><td>2</td><td>100</td><td>20</td><td>300</td></tr>
<tr><td>3</td><td>200</td><td>300</td><td>20</td></tr>
</table></td></tr>
<tr><td>CO5</td><td>Discuss briefly the quick response techniques for travel demand estimation.</td></tr>
</table>

24CEE7113	OPTIMIZATION TECHNIQUES IN CIVIL ENGINEERING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course aims to impart fundamental concepts of optimization problem formulation across diverse civil engineering domains. It covers a range of algorithms designed for solving optimization problems in real-world scenarios. Upon completion, students will possess the skills to formulate and address practical optimization challenges in civil engineering through the application of appropriate methods and algorithms.

Prerequisite: Nil

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

CO1	Formulate civil engineering design problem as an optimization problem. (Apply Level)
CO2	Apply appropriate techniques to solve a non-linear optimization problem in hand. (Apply Level)
CO3	Formulate and solve linear programming problem for engineering applications. (Evaluate Level)
CO4	Demonstrate the use of computer programming or software tool for solving an optimization problem. (Apply Level)
CO5	Demonstrate the applicability of search algorithms for real field civil Engineering problem through relevant case studies. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	3	2	-	-	-	-	-	-	2
CO5	3	3	-	2	2	-	-	-	-	3	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate			✓	
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Introduction to Optimization: Steps, Terminologies, and Problem-Solving)

Introduction to optimization - steps in optimization problem solving, basic terminologies, concavity and convexity of mathematical functions, types of optimization problems and solution methods.

Optimization problem formulation - objective function, constraints. Formulation of different types of optimization problems - minimum weight design of beams, columns, trusses and frames, water quality modelling, minimum cost design.

MODULE II (Solution of Optimization Problems)

Solution of optimization problems - Single variable unconstrained optimization techniques - one-dimensional minimization. Elimination methods - Interval halving, Fibonacci search and Golden section methods. Gradient Based methods: Newton-Raphson method, Secant method, Bisection method.

MODULE III (Gradient-Based Optimization Methods and Conceptual Ideas of Random Search and Grid Search)
Gradient based methods - steepest descent method, Fletcher Reeves method, Newton method, Quasi Newton method - DFP method, BFGS method. Conceptual ideas of random search method and grid search method.
MODULE IV (Linear Programming and Simplex Method)
Linear programming, simplex method - dual problem, primal-dual relationship, economic interpretation of dual solution, introduction to sensitivity analysis examples of applications of linear programming in engineering. Two phase solution of Simplex method.
MODULE V (Optimization Techniques Overview)
Integer programming - Gomory's cutting plane method. Geometric programming - minimum weight design of trusses. Conceptual ideas of constraint handling - Penalty function approach, multi-objective optimization, dynamic programming and Bellman's principle of optimality, Reliability based optimization, Use of search algorithms (general philosophy only), familiarizing different meta-heuristic optimization methods and swarm intelligence algorithms.

Text books

1. Rajasekharan S. "Numerical Methods in Science and Engineering" S Chand & company 2003.
2. S.S. Rao, Optimisation Theory and applications, Wiley Eastern.
3. Belegundu, Optimisation concepts and Applications Engineering.
4. S. S. Rao, Engineering Optimization, New Age International (P) Ltd. Publishers.
5. J. S. Arora, Introduction to Optimum Design, McGraw-Hill Book Company.
6. K. Deb, Multiobjective Optimization using Evolutionary Algorithms, John Wiley and Sons.

Reference books

1. Grewal B.S. "Numerical Methods in Engineering and Science" Khanna Publishers.
2. Chapra S.C. and Canale R.P. "Numerical Methods for Engineers" Mc Graw Hill 2006.
3. Ketter and Prawel "Modern Methods for Engineering Computations" Mc Graw Hill.
4. Terrence. J. Akai "Applied Numerical Methods for Engineers", Wiley publishers 1994.
5. Fox R. L., Optimisation methods in Engineering Design, Addison Wesely.
6. Ravindran, D. T. Phillips, J. J. Solberg, Operations Research – Principles and Practice, John Wiley and Sons.
7. Ravindran, K. M. Ragsdell, G. V. Reklaitis, Engineering Optimization – Methods and Applications, John Wiley and Sons.

8. Bazaraa M. S., H. D. Sherali, and C. M. Shetty, Nonlinear Programming: Theory and Algorithms, Wiley-Interscience.
9. Rajasekharan S. "Numerical Methods for Initial and Boundary value problems," Khanna publishers 1989.

No.	COURSE CONTENTS AND LECTURE SCHEDULE	No. of Hours (36)
	MODULE I (8 hours)	
1.1	Introduction to optimization – steps in optimization problem solving.	1
1.2	Introduction to optimization – basic terminologies, concavity and convexity of mathematical functions.	1
1.3	Types of optimization problems and solution methods.	1
1.4	Optimization problem formulation – objective function, constraints.	1
1.5	Formulation of different types of optimization problems – minimum weight design of beams.	1
1.6	Formulation of different types of optimization problems – minimum weight design of columns, trusses and frames.	1
1.7	Formulation of different types of optimization problems – water quality modeling	1
1.8	Formulation of different types of optimization problems – minimum cost design.	1
	MODULE II (6 hours)	
2.1	Solution of optimization problems - Single variable unconstrained optimization techniques.	1
2.2	Solution of optimization problems - one dimensional minimization.	1
2.3	Elimination methods - Interval halving.	1
2.4	Elimination methods - Fibonacci search and Golden section methods.	1
2.5	Gradient Based methods: Newton-Raphson method, Secant method.	1
2.6	Gradient Based methods: Bisection method.	1
	MODULE III (8 hours)	
3.1	Gradient based methods - steepest descent method.	1
3.2	Gradient based methods - Fletcher Reeves method.	1

3.3	Gradient based methods - Newton method.	1
3.4	Quasi Newton method - DFP method.	1
3.5	Quasi Newton method - BFGS method.	1
3.6	Quasi Newton method - BFGS method.	1
3.7	Conceptual ideas of random search method.	1
3.8	Conceptual ideas of grid search method.	1
MODULE IV (8 hours)		
4.1	Linear programming.	1
4.2	Simplex method - dual problem.	1
4.3	Simplex method - primal-dual relationship.	1
4.4	Simplex method - economic interpretation of dual solution.	1
4.5	Introduction to sensitivity analysis.	1
4.6	Examples of applications of linear programming in engineering.	1
4.7	Examples of applications of linear programming in engineering.	1
4.8	Two phase solution of Simplex method.	1
MODULE V (6 hours)		
5.1	Integer programming - Gomory's cutting plane method.	1
5.2	Geometric programming - minimum weight design of trusses.	1
5.3	Conceptual ideas of Constraint handling.	1
5.4	Penalty function approach.	1
5.5	Multi-objective optimization, dynamic programming and Bellman's principle of optimality.	1
5.6	Reliability based optimization, Use of search algorithms - (general philosophy only) familiarizing different meta-heuristic optimization methods.	1

5.7	Use of search algorithms - swarm intelligence algorithms.	1
CO Assessment Questions		
CO1	1. Formulate a optimization problem with constraints for determining the optimum dimensions of a simply supported beam of span 6 m subjected to a uniformly distributed load of 30 kN/m. Allowable stress in bending is 10N/mm^2 and allowable stress in shear is 1N/mm^2.Allowable deflection is span/300. 2. Formulate a optimization problem with constraints for determining the optimal slope and dimensions for the members of the truss if the shape, loads and span are given.	
CO2	Minimize f (x, y) = x - y + 2x^2 + 2xy + y^2 starting from the point x = (0,0) using fletcher reeves' method.	
CO3	A bakery manufactures two kinds of cookies, chocolate chip, and caramel. The bakery forecasts the demand for at least 80 caramel and 120 chocolate chip cookies daily. Due to the limited ingredients and employees, the bakery can manufacture at most 120 caramel cookies and 140 chocolate chip cookies daily. To be profitable the bakery must sell at least 240 cookies daily. Each chocolate chip cookie sold results in a profit of 0.75 and each caramel cookies produces 0.88 profit. a) How many chocolate chip and caramel cookies should be made daily to maximize the profit? b) Compute the maximum revenue that can be generated in a day.	
CO4	Develop a computer programme to solve a linear programming problem using the simplex method, considering both the primal and dual problems.	
CO5	Prepare a presentation demonstrating the applicability of search algorithm using case studies.	

OPEN ELECTIVE-1 /INDUSTRY ELECTIVE

24CEI714	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course on Environmental Impact Assessment equips students with the knowledge and skills to assess the consequences of human activities on the environment. In this, the students will explore the fundamental principles and methodologies essential for evaluating and mitigating the environmental consequences of development projects. After the completion of this course, the students will have a comprehensive understanding of sustainable practices, regulatory frameworks, and the role of EIA in fostering responsible environmental stewardship.

Prerequisite: 24MCT406 Environmental science

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

CO1	Outline the environmental legislations in India. (Understand Level)
CO2	Explain the environmental clearance process in India. (Understand Level)
CO3	Discuss the different EIA methodologies. (Understand Level)
CO4	Describe the environmental management plan and environmental audit. (Understand Level)
CO5	Interpret EIA reports. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	3	-	-	-	-	-	-
CO2	-	-	-	-	-	-	1	-	-	-	-	-
CO3	3	-	-	-	-	-	1	-	-	-	-	-
CO4	1	-	-	-	-	2	2	-	-	-	-	-
CO5	-	-	-	-	-	-	1	-	2	2	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Environmental Regulations)

Definition, Need for EIA, Evolution of EIA: Global & Indian scenario - Environmental legislations in India - The Water (Prevention & Control of Pollution) Act 1974 - The Air (Prevention & Control of Pollution) Act 1981 - The Environmental (Protection) Act 1986 - Environmental standards for water, air and noise quality - EIA Notification 1994, 2006 and subsequent amendments.

MODULE II (Environmental Clearance Process in India)

Environmental clearance process in India: Screening, Scoping, baseline data collection, Public Consultation, Appraisal - Form1, Category of projects - Generic structure of EIA report - Terms of Reference (ToR) - Types of EIA: strategic, regional, sectoral, project level - Rapid EIA and Comprehensive EIA - Initial Environmental Examination (IEE).

MODULE III (EIA Methodologies)
EIA methodologies (overview only): Ad hoc, checklist, matrix, network (Fault Tree Analysis, Event Tree Analysis and HAZOP), overlay, Impact Prediction, Evaluation and Mitigation (overview only): Prediction and assessment of the impact on water (surface water and groundwater), air, and noise environment - assessment of ecological impacts and Socio-economic Impacts.
MODULE IV (Mitigation and Monitoring)
Environmental Management Plan (EMP): Goal and purpose - Importance of EMP - Content of an EMP - Role of environmental monitoring program. Environment Audit: need for audit - audit types and benefits - environmental audit procedure. ISO 14001 standards: Importance, salient features - Stages in implementation – Benefits.
MODULE V (Case Studies)
EIA case studies (Indian) - highway project, hydroelectric power plant, airport project, quarry mining project and solid waste management project.

Text books

1. Ministry of Environment & Forests, Govt. of India, EIA Notifications 1994, 2006 and amendments.
2. Anji M Mareddy, Environmental Impact Assessment- Theory and Practice, 2017, Elsevier.
3. Anjaneyulu Yerramilli, Valli Manickam, Environmental Impact Assessment Methodologies, 3rd edition, 2020, B S Publications.

Reference books

1. Larry W Canter, Environmental Impact Assessment, 1995, McGraw Hill Inc., New York.
2. Ram B. Khadka, Steve Gorzula, Ananda R Joshi, Shailendra Guragain, and Ajay B. Mathema, Environmental Impact Assessment: Process, Methods and Practices of South Asia (Bangladesh, Bhutan, India and Nepal), 1st edition (2013), School of Environmental Science and Management (SchEMS) and Asian Environmental Solution, Nepal (AES/N).

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (6 hours)	
1.1	Definition, Need for EIA, Evolution of EIA: Global & Indian Scenario.	1
1.2	Environmental legislations in India - The Water (Prevention & Control of Pollution) Act 1974.	1
1.3	The Air (Prevention & Control of Pollution) Act 1981.	1
1.4	The Environmental (Protection) Act 1986 - Environmental standards for water, air and noise quality.	1

1.5	EIA Notification 1994, 2006 and subsequent amendments.	1
1.6	EIA Notification 1994, 2006 and subsequent amendments.	1
MODULE II (9 hours)		
2.1	Environmental clearance process in India – flowchart.	1
2.2	Screening.	1
2.3	Scoping.	1
2.4	Baseline data collection.	1
2.5	Public Consultation.	1
2.6	Appraisal Form1-Category of projects- Generic structure of EIA report.	1
2.7	Terms of Reference (ToR).	1
2.8	Types of EIA: strategic, regional, sectoral, project level.	1
2.9	Rapid EIA and Comprehensive EIA - Initial Environmental Examination (IEE).	1
MODULE III (10 hours)		
3.1	EIA methodologies: Ad hoc, checklist.	1
3.2	Matrix, overlay.	1
3.3	Network (Fault Tree Analysis, Event Tree Analysis and HAZOP)	1
3.4	Impact Prediction, Evaluation and Mitigation.	1
3.5	Prediction and assessment of the impact on water (surface water)	1
3.6	Prediction and assessment of the impact on water (groundwater)	1
3.7	Prediction and assessment of the impact on air.	1
3.8	Prediction and assessment of the impact on noise environment.	1
3.9	Assessment of ecological impacts.	1

3.10	Assessment of Socio-economic Impacts.	1
MODULE IV (6 hours)		
4.1	Environmental Management Plan (EMP): Goal and purpose - Importance of EMP.	1
4.2	Content of an EMP - Role of environmental monitoring program.	1
4.3	Environment Audit: need for audit - audit types and benefits.	1
4.4	Environmental audit procedure.	1
4.5	ISO 14001 standards: Importance, salient features.	1
4.6	ISO 14001 standards: Stages in implementation – Benefits.	1
MODULE V (5 hours)		
5.1	EIA case studies on highway project.	1
5.2	EIA case studies on hydroelectric power plant.	1
5.3	EIA case studies on airport project.	1
5.4	EIA case studies on quarry mining project.	1
5.5	EIA case studies on solid waste management project.	1

CO Assessment Questions	
CO1	Explain the environmental clearance process as per EIA notification 2006.
CO2	What is screening? What are the different ways of screening?
CO3	Enlist and explain the different types of checklists.
CO4	Discuss the importance of an EMP document.
CO5	Explain the environmental impacts of a thermal power plant.

24CEI724	ROAD SAFETY AND MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course is designed to provide an understanding of the critical aspects that govern road safety and the effective management of transportation systems. The course explores road design, traffic management, risk assessment, and safety interventions. At the end of the course, students will be equipped to understand the factors that contribute towards reducing accidents and improving road safety.

Prerequisite: Nil

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

CO1	Identify the present status of road safety and the need for implementing risk management measures. (Remember Level)
CO2	Elaborate on the fundamental principles associated with the safe geometric design of roads. (Understand Level)
CO3	Discuss key concepts related to traffic engineering and different measures for managing traffic to enhance road safety. (Understand Level)
CO4	Recognize the necessity for data analysis on road safety and assessment of associated risks. (Understand Level)
CO5	Explain the methods and approaches for improving road safety by preventing road accidents. (Understand Level)

CO – PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	1	-	-	-	-	-	-	-	-	-
CO2	2	-	1	-	-	-	-		-	-	-	-
CO3	2	-	1	-	-	-	1	-	-	-	-	-
CO4	2	-	1	-	-	-	1	-	-	-	-	-
CO5	2	-	1	-	-	-	1	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test 1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS
MODULE I (Introduction to Road Safety)
Importance of road safety, Economic and social implications of road safety; Historical overview of road safety, improvements, and milestones; Global road safety statistics - road traffic accidents, injuries, and fatalities, the Safety situation in India; International and national road safety policies, laws, and regulations; Three 'E's of road safety – Engineering, Enforcement and Education; Challenges and emerging issues in road safety – distracted driving, autonomous vehicles.
MODULE II (Safe Geometric Design of Roads)
Objectives and requirements of safe highway geometric design; Factors governing geometric design - design speed, topography, vehicle, human, environmental factors and pavement surface characteristics; Standards and guidelines for road safety considerations – IRC; Cross Section Elements: Right of way and width consideration, roadway, shoulders, curbs, camber, cross slope; Sight distances, horizontal and vertical alignments (concept only); Safety at intersections and roundabouts; Forgiving designs – Medians, Guardrails, Barriers.
MODULE III (Traffic Engineering for Safety)
Fundamentals of traffic engineering – flow, speed, density; Significance of traffic engineering in road safety; Traffic Control Devices – functions and importance; Traffic Signs – Types and significances; Pavement markings – Types and significances; Night time driving: visibility, Retro-reflectivity of signs and markings; Traffic Calming Measures – types and functions; Safety issues for public transport users and non-motorized transport users.
MODULE IV (Data Analysis and Risk Assessment)
Research in road safety, Collection, and Analysis of Accident Data; Causes of accidents - Types of the crashes - Crash summary report, Accident forensic investigation, Condition and Collision Diagrams; Accident reconstruction - Crash data, skid marks, and vehicle damage analysis; Expert Witness Analysis, Crash factor matrix; Accident rate modeling, Prediction models (concept only).
MODULE V (Risk Management and Prevention)
Integrated safety measures - Roadway design enhancements, Infrastructure safety measures; Safety enhancement projects, Crash countermeasures, Crash location treatments; Road Safety Audits – Stages and Significance; Road Safety Awareness Programs, Enforcement of Laws – Limitations; Road Safety and Advanced Technologies – Smart Roads and Autonomous vehicles; Intelligent Transportation Systems for Safety.
Textbooks 1. Kadiyali and Lal, Principles and Practices of Highway Engineering, Khanna Publishers. 2. Khanna and Justo, Highway Engineering, 10th Edition, Nem Chand & Brothers. 3. Handbook of Road Safety Measures, Second Edition, Rune Elvik, Alena Hoye, Truls Vaa, Michael Sorenson.

Reference books

1. L.R. Kadiyali, Traffic Engineering and Transportation Planning – Khanna Publishers.
2. C.S. Papacostas, Fundamentals of Transportation Engineering – Prentice Hall India.
3. C. Jotinkhisty, B. Kent Lall, Transportation Engineering – An Introduction.
4. Richardo G Sigua, Fundamentals of Traffic Engineering.
5. Road Safety Report by NCHRP.
6. All relevant Indian Road Congress (IRC) codes.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (34)
	MODULE I (6 Hours)	
1.1	Importance of road safety, Economic and social implications.	1
1.2	Historical overview of road safety, improvements, and milestones.	1
1.3	Global road safety statistics - road traffic accidents, injuries, and fatalities, Safety situation in India.	1
1.4	International and national road safety policies, laws, and regulations.	1
1.5	Three 'E's of road safety – Engineering, Enforcement and Education.	1
1.6	Challenges and emerging issues in road safety – distracted driving, autonomous vehicles.	1
	MODULE II (7 Hours)	
2.1	Objectives and requirements of safe highway geometric design.	1
2.2	Factors governing geometric design - design speed, topography, vehicle, human, pavement surface characteristics, and environmental factors.	1
2.3	Standards and guidelines for road safety considerations – IRC.	1
2.4	Cross Section Elements: Right of way and width consideration, roadway, shoulders, curbs, camber, cross slope.	1
2.5	Sight distances, horizontal and vertical alignments.	1
2.6	Safety aspects at intersections and roundabouts.	1
2.7	Forgiving designs – Medians, Guardrails, Barriers.	1

MODULE III (7 Hours)		
3.1	Fundamentals of traffic engineering – flow, speed, density Significance of traffic engineering in road safety.	1
3.2	Traffic Control Devices - functions and importance.	1
3.3	Traffic Signs – Types and significances.	1
3.4	Pavement markings – Types and significances.	1
3.5	Night time driving: visibility, Retro-reflectivity of signs and markings.	1
3.6	Traffic Calming Measures – types and functions.	1
3.7	Safety issues for public transport and non-motorized transport users.	1
MODULE IV (7 Hours)		
4.1	Research in road safety, Collection and Analysis of Accident Data.	1
4.2	Causes of accidents.	1
4.3	Types of road crashes.	1
4.4	Crash summary report, Accident forensic investigation, Condition and Collision Diagrams.	1
4.5	Accident reconstruction.	1
4.6	Expert Witness Analysis, Crash factor matrix.	1
4.7	Accident rate modeling, Prediction models.	1
MODULE V (7 Hours)		
5.1	Roadway design enhancements, Infrastructure safety measures.	1
5.2	Safety enhancement projects, Crash countermeasures, Crash location treatments.	1
5.3	Road Safety Audits – Stages and Significance.	1
5.4	Road Safety Awareness Programs, Enforcement of Laws – Limitations.	1
5.5	Road Safety and Advanced Technologies – Smart Roads and Autonomous Vehicles.	1
5.6	Intelligent Transportation Systems for Safety.	1
5.7	Intelligent Transportation Systems for Safety.	1

CO Assessment Questions	
CO1	Discuss the challenges associated with improving road safety in the Indian scenario.
CO2	Explain the concept of forgiving designs with a suitable example.
CO3	Classify different types of traffic signs with neat sketches.
CO4	Distinguish between collision diagrams and condition diagrams.
CO5	Elaborate on any two latest technologies that can be used as safety management measures.

24CEI734	PROJECT MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course intends to introduce the basic concepts of project management. The course provides insight into the planning and scheduling of projects and an awareness of quality, safety and risk management in projects. Upon completion of the course, the students will be proficient in project planning and management.

Prerequisite: Nil

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

CO1	Describe the procedure for planning and executing projects. (Understand Level)
CO2	Apply the concepts of engineering economics in economic decision-making. (Apply Level)
CO3	Apply scheduling techniques in project planning and control. (Apply Level)
CO4	Explain the project risk management process. (Understand Level)
CO5	Describe safety and quality management and its importance in projects. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	1	-
CO2	3	-	-	-	-	-	-	-	-	-	3	-
CO3	3	-	-	-	-	-	-	-	-	-	2	-
CO4	1	-	-	-	-	-	1	-	-	-	1	-
CO5	1	-	-	-	-	2	-	-	-	-	1	-

Assessment Pattern for Theory Component

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply		✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA							
Course Structure [L-T-P-J]	**Attendance**	**Theory [L]**			**Practical [P]**		**Total Marks**
		Assignment	**Test-1**	**Test-2**	**Class work**	**Lab Exam**	
3-0-0-0	**5**	**15**	**10**	**10**			**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hrs

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Introduction to Project Management)

Introduction to projects, project management, characteristics of projects, project stakeholders.

Life cycle of a project – phases.

Fundamentals of Engineering economics, techniques to assess economic feasibility and to compare alternative proposals – Net Present Value, Rate of Return analysis, Benefit-cost analysis. (Problems with equal lives only)

MODULE II (Tendering and Contracting)

Tendering: types of tenders, stages in tendering.

Contracts: Importance of contracts, Types of Contracts – item rate contract, lumpsum contract, percentage rate contract, turnkey contracts, concession contracts – BOT, parties to a contract.

MODULE III (Project scheduling)

Work break down structure.

Techniques of planning – Bar charts, Mile Stone Charts.

Network representation – Activity on Node (AoN) Diagram.

Network analysis – Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT) – concepts and problems.

Precedence Diagramming Method – types of relationships – concept of lead and lag.

MODULE IV (Resource Scheduling and Project Control)

Time-Cost trade-off on construction projects – Classification of costs, compression of networks, cost optimization through the crashing of a network.

Resource smoothing and resources levelling. (brief discussion only)

Earned value analysis – measures of performance.

MODULE V (Project Risk, Quality and Safety Management)

Project risk management – Risk identification, Risk analysis, Risk response planning.

Project quality management – inspection, quality control, quality assurance, total quality management.

Causes of accidents, principles of safety, factors affecting safety, roles of safety personnel, training for safety awareness and implementation, safety legislation, safety manuals.

Text Books

1. Chandra P., Projects – Planning, Analysis, Selection, Implementation Review, 9th edition, McGraw Hill Education India Pvt. Ltd., 2019.
2. Meredith J. R. and Mantel Jr. S. J., Project Management: A Managerial Approach, 7th Edition, John Wiley & Sons, 2009.
3. Jha K. N., Construction Project Management Theory & Practice, Pearson India Education Services Pvt. Ltd., 2nd edition, 2015.

Reference books

1. Joy P. K., Total Project Management - The Indian Context, New Delhi, Macmillan India Ltd., 1994.Moder J. J., Philips C. R. and Davis E. W., Project Management with CPM, PERT and Precedence Diagramming, Van Nostrand Reinhold Company Inc., 1983.
2. Kerzner H., Project Management, 12th Edition, John Wiley & Sons, 2017.
3. Larson E. W., Gray C. F. and Joshi R., Project Management: The Managerial Process, 8th edition, McGraw Hill, 2021.
4. Wiest, J. D. and Levy, F. K., A Management Guide to PERT/CPM, Prentice Hall, 2nd edition, 2003.

5. Cleland D. L. and Ireland L. R., Project Management: Strategic Design and Implementation, McGraw Hill, 2002.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (35)
	MODULE I (9 hours)	
1.1	Introduction to projects, project management, characteristics of projects. Project stakeholders.	1
1.2	Life cycle of a project – pre-project phase.	1
1.3	Life cycle of a project – project phase, post-project phase.	1
1.4	Fundamentals of Construction economics – time value of money.	1
1.5	Interest factors.	1
1.6	Problems on interest factors.	1
1.7	Techniques to conduct economic feasibility and to compare alternative proposals – Net Present Value. (Problems with equal lives only)	1
1.8	Rate of Return analysis. (Problems with equal lives only)	1
1.9	Benefit-cost analysis. (Problems with equal lives only)	1
	MODULE II (5 hours)	
2.1	Tendering: types of tenders. Stages in tendering – advertisement of tenders.	1
2.2	Stages in tendering – submission, opening, scrutiny of tenders, award of contract.	1
2.3	Contracts – Importance of contracts, Types of contracts – item rate contract.	1
2.4	Types of contracts – lumpsum contract, percentage rate contract.	1
2.5	Types of contracts – turnkey contracts, concession contracts – BOT, parties to a contract.	1
	MODULE III (8 hours)	
3.1	Work break-down structure, estimating durations.	1
3.2	Techniques of planning – Bar charts, Mile Stone Charts.	1
3.3	Network representation – Activity on Node (AoN) Diagram.	1
3.4	Network analysis – Critical Path Method (CPM) – determination EST, EFT, LST, LFT – identification of critical path.	1
3.5	CPM – computation of free float, independent float and interfering float.	1
3.6	Programme Evaluation and Review Technique (PERT) – three time estimates – computation of expected time.	1
3.7	PERT – calculation of the probability of completion.	1

3.8	Precedence Diagramming Method – types of relationships – the concept of lead and lag.	1
MODULE IV (6 hours)		
4.1	Time-Cost trade-off on construction projects – Classification of costs.	1
4.2	Compression of networks, cost optimization through the crashing of a network.	1
4.3	Problem on crashing.	1
4.4	Resource allocation and levelling. (concept only)	1
4.5	Earned value analysis – measures of performance.	1
4.6	Problem on earned value analysis.	1
MODULE V (7 hours)		
5.1	Project risk management – Risk identification.	1
5.2	Risk analysis, Risk response planning.	1
5.3	Project quality management – inspection, quality control, quality assurance.	1
5.4	Total quality management.	1
5.5	Causes of accidents, principles of safety, factors affecting safety.	1
5.6	Roles of safety personnel, training for safety awareness and implementation.	1
5.7	Safety legislation, safety manuals.	1

CO Assessment Questions

CO1: Illustrate and explain the phases in a project life cycle.

CO2: A company plans to purchase equipment for research purpose. Perform PW analysis to determine the economical alternative among the three alternatives with costs as shown below. The MARR is 10% per year.

	A	B	C
First cost (Rs.)	45000	35000	60000
Annual operating cost (Rs.)	9000	7000	500
Salvage value (Rs.)	2000	3500	1000
Life in years	8	8	8

CO3: For the given data, draw an AON network and determine the critical path. Also find the total float, free float, independent float and interfering float of each activity.

Activity	A	B	C	D	E	F	G	H	I
Predecessor	-	A	A	C	B	B, D	C	F, G	E, H
Duration (days)	4	6	4	2	4	5	3	4	2

CO4	Discuss the techniques that can be adopted for identification of risks in projects.
CO5	Explain total quality management.

MINOR & HONOURS COURSES

24CEM709	MINI PROJECT	L	T	P	J	S	C	Year of Introduction
		0	0	0	4		4	2024

Preamble: The objective of mini project is to enable the student to take up investigative study in the broad field of Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department for a group of five students under the guidance of a supervisor. This is expected to provide a good initiation for the students in Research and Development work. The assignment includes

- Survey and study of published literature on the assigned topic.
- Preparing an Action plan for conducting the investigation, including team work.
- Working out a preliminary Approach to the problem relating to the assigned topic.
- Conducting preliminary analysis/modelling/simulation/experiment/design.
- Feasibility study.
- Preparing a written report on the study conducted for presentation.

Prerequisite: Nil

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

CO1	Identify and synthesize problems and propose solutions to them. (Analyse Level)
CO2	Prepare work plan and liaison with the team in completing as per schedule. (Apply Level)
CO3	Validate the above solutions by theoretical calculations and through experimental investigations. (Apply Level)
CO4	Write technical reports and develop proper communication skills. (Apply level)
CO5	Present the data and defend ideas. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	-	-	-	3	3	-	2
CO2	3	-	-	3	-	-	-	3	3	3	3	-
CO3	3	3	3	3	3	-	-	-	-	3	-	-
CO4	-	-	-	-	3	-	-	3	3	3	-	1
CO5	3	-	3	3	-	-	-	3	3	3	-	1

Assessment Pattern

Bloom's Category	Continuous assessment tools		
	Evaluation 1	Evaluation 2	Evaluation 3
Remember			
Understand	✓	✓	✓
Apply	✓	✓	✓
Analyse	✓	✓	✓
Evaluate			
Create			

Mark Distribution of CIA						
Course Structure [L-T-P-J]	**Project guide**	**Interim Evaluation**	**Draft Report**	**Final Report**	**Final Evaluation**	**Total Marks**
0-0-0-4	25	25	5	10	35	**100**

Total Mark distribution	
Total Marks	**CIA (Marks)**
100	100

General guidelines

- The report and the presentation shall be evaluated by a team of internal members comprising three senior faculty members based on the style of presentation, technical content, adequacy of reference, depth of knowledge and overall quality of the report.
- It will be a group activity with a maximum of five members in a group, where each group has to identify suitable topic in their domain
- The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of semester.

24CEH719	STRUCTURAL DYNAMICS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: The objective of this course is to expose students to the fundamentals of structural dynamics. The course focuses on imparting knowledge of dynamic analysis of single-degree, multi-degree and distributed systems. After this course students will be able to model single and multi-degree freedom systems for dynamic analysis and perform free and forced vibration analysis.

Prerequisite: 24CET401 Structural Analysis

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Recall principles and theorems related to structural dynamics. (Remember Level)
CO2	Develop equation of motion of single and multi-degree of freedom systems. (Understand Level)
CO3	Perform dynamic analysis of single and multi-degree of freedom systems. (Apply Level)
CO4	Generate the time histories of responses of SDOF systems by applying numerical techniques. (Apply Level)
CO5	Analyse and design vibration isolation systems. (Apply Level)
CO6	Perform free vibration analysis of beams. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	3	-	-	-	-	-	-	-
CO5	3	3	3	-	-	-	-	-	-	-	-	-
CO6	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS
Module I (Single Degree of Freedom Systems – Harmonic Load)
Review of systems with single degree of freedom - Equation of motion, undamped and damped free vibration responses. Response of single degree of freedom systems to harmonic loading – response of undamped and damped systems, Dynamic Magnification Factor, Measurement of damping – Half power band width method.
Module II (SDOF Systems – General Loads, Vibration Isolation)
Response of SDOF systems to step, rectangular and triangular loads, Impulse response function (IRF), Duhamel Integral – undamped and damped systems. SDOF system subjected to support motion, equation of motion.

Vibration isolation – force isolation and displacement isolation, Transmissibility, Design of vibration isolation systems.
Vibration absorber – Tuned Mass Damper (concept only). Vibration measuring instruments.

Module III (Multi-Degree of Freedom Systems – Free and Forced Vibration)

MDOF systems – equations of motion. Shear building frames.
Undamped free vibration - Natural frequencies and mode shapes, Orthogonality of mode shapes.
Forced vibration analysis of MDOF systems – Mode superposition method

Module IV (MDOF Systems Subjected to Support Motion, Numerical Evaluation of Dynamic Response)

MDOF system subjected to support motion- equation of motion.
Numerical evaluation of dynamic response of SDOF systems. Time stepping methods - central difference method, Newmark's method – average acceleration method.
Numerical solution of MDOF systems.

Module V (Distributed Parameter Systems, Variational Formulation)

Introduction to distributed parameter systems – differential equation for beam flexure, Natural frequencies and mode shapes of simply supported beam. Natural frequencies of cantilever and fixed beams (formulation only).
Axial vibration of rods.
Introduction to variational formulation, Hamilton's principle, Lagrange's equation.

Text books

1. Mario Paz, Structural Dynamics – Theory and Computation, CBS Publishers and Distributors, Delhi.
2. Mukhopadhyay M, Structural Dynamics - Vibrations and Systems, Ane Books, India, Delhi.

Reference books

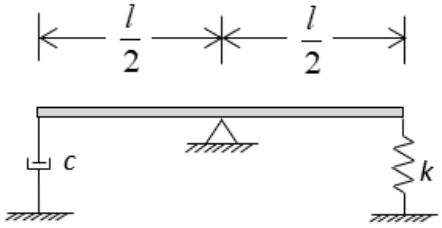
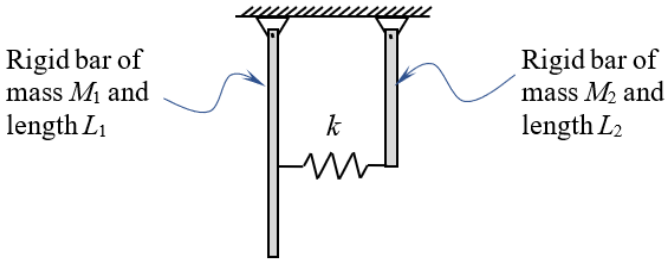
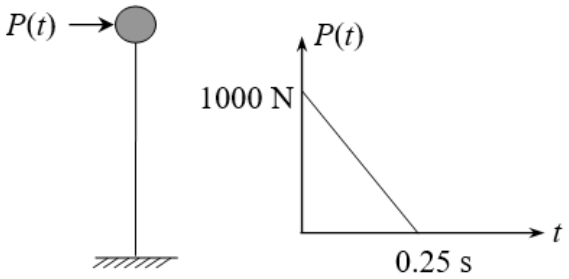
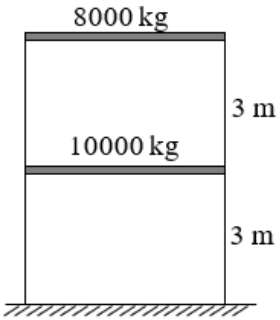
1. Anil K. Chopra, Dynamics of Structures – Theory and application to Earthquake Engineering, Prentice Hall of India Pvt Ltd, New Delhi.
2. Clough R W and Penzien J, Dynamics of Structures, McGraw Hill, New Delhi.
3. Biggs J M, Introduction to Structural dynamics, McGraw Hill, New Delhi.
4. Humar J, Dynamics of Structures, CRC Press, Netherlands.
5. Roy R Craig, Structural Dynamics – An Introduction to Computer Method, John Wiley & Sons, New York.
6. Thomson W T, Theory of Vibration with Application, Pearson Education, New Delhi.
7. Weaver W, Timoshenko S P, Young D H, Vibration Problems in Engineering, John Wiley & Sons, USA.

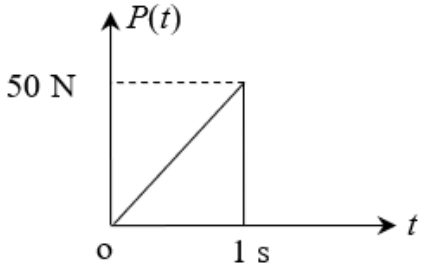
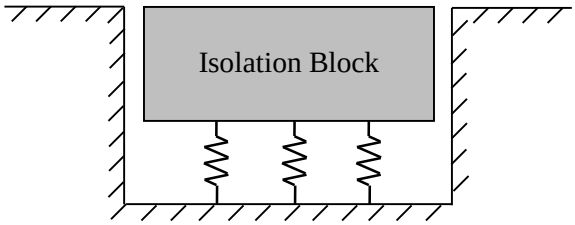
COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (48)
Module I (11 Hours)		
1.1	Review of systems with single degree of freedom (SDOF), Equation of motion of spring-mass systems, Free vibration responses.	1

1.2	Equation of motion of general SDOF systems, identification of mass, stiffness and damping, Computation of natural frequency.	1
1.3	Working out problems – EOM and determination of natural frequency of general SDOF systems.	1
1.4	Response of SDOF systems to harmonic load – undamped system.	1
1.5	Response of SDOF systems to harmonic load – damped system. Transient and steady state responses.	1
1.6	Working out Problems – SDOF system subjected to harmonic loading.	1
1.7	Variation of steady state amplitude with load frequency, Dynamic magnification factor (DMF).	1
1.8	Variation of DMF with frequency ratio - Variation of phase angle with frequency ratio.	1
1.9	Measurement of damping – half power bandwidth method.	1
1.10	Working out Problems – SDOF systems subjected to harmonic loading (Session 1)	1
1.11	Working out Problems – SDOF systems subjected to harmonic loading. (Session 2)	1
Module II (10 Hours)		
2.1	Response of SDOF systems to step and rectangular loads.	1
2.2	Response of SDOF systems to triangular loads.	1
2.3	Impulse response function (IRF) – undamped and damped systems.	1
2.4	Duhamel Integral – undamped and damped systems.	1
2.5	SDOF system subjected to support motion, equation of motion.	1
2.6	Working out problems – SDOF systems to support motion.	1
2.7	Vibration isolation – force isolation and displacement isolation.	1
2.8	Transmissibility – Force and displacement transmissibility.	1
2.9	Design of vibration isolation systems.	1
2.10	Vibration absorber – Tuned Mass Damper (concept only). Vibration measuring instruments.	1
Module III (10 Hours)		
3.1	Introduction to MDOF systems – equations of motion.	1
3.2	Shear building frames – spring-mass models – derivation of equations of motion.	1
3.3	Equations of motion of general MDOF systems.	1
3.4	Undamped free vibration – Natural frequencies and mode shapes.	1
3.5	Orthogonality of mode shapes – proof.	1
3.6	Working out problems – Natural frequencies and mode shapes of MDOF systems. (Session 1)	1
3.7	Working out problems – Natural frequencies and mode shapes of MDOF systems. (Session 2)	1

3.8	Free vibration response of MDOF systems.	1
3.9	Forced vibration analysis of MDOF systems – Mode superposition method.	1
3.10	Forced vibration analysis of 2-dof systems.	1
Module IV (9 Hours)		
4.1	MDOF system subjected to support motion – equation of motion.	1
4.2	Analysis of MDOF system due to support motion.	1
4.3	Working out problems – MDOF systems subjected to support motion.	1
4.4	Numerical evaluation of dynamic response – time stepping methods.	1
4.5	Numerical solution of SDOF systems using central difference method.	1
4.6	Numerical solution of SDOF systems using Newmark's method.	1
4.7	Working out problems – numerical response of SDOF systems. (Session 1)	1
4.8	Working out problems – numerical response of SDOF systems. (Session 2)	1
4.9	Numerical solution of MDOF systems using any one method – formulation.	1
Module V (8 Hours)		
5.1	Introduction to distributed parameter systems – differential equation for beam flexure.	1
5.2	Beam flexure – solution of PDE.	1
5.3	Natural frequencies and mode shapes of simply supported beam.	1
5.4	Natural frequencies of cantilever and fixed beams – formulation of equations	1
5.5	Axial vibration of rods	1
5.6	Introduction to variational formulation, Hamilton's principle.	1
5.7	Lagrange's equation – derivation of equation	1
5.8	Equation of motion using Lagrange's equation.	1

CO Assessment Questions		
CO1	1	State and explain the orthogonality conditions of mode shapes.
	2	Explain how Lagrange's equation is used for developing the equation of motion of dynamic systems.
CO2	1	A rigid bar of mass m is hinged at its mid-point and supported as shown in figure. Assuming small oscillations, derive the equation of motion of the system.

		
	2	Derive the equation of motion of the system shown in figure for small oscillations. 
CO3	1	A tower structure with mass 120 kg and stiffness 5000 N/m is subjected to a blast load as shown. Find the response of the system. Neglect damping. 
	2	Find the natural frequencies and mode shapes of the two storey shear building frame shown in figure. Flexural rigidity of the columns $= 3.2 \times 10^6$ Nm². Sketch the mode shapes also. 
CO4	1	A single degree of freedom spring-mass system is subjected to a harmonic load $P(t) = P_0 \cos(\lambda t)$. Assuming that the system starts from rest, generate the plot of displacement time history using *Central Difference Method*. Use suitable values of system parameters and load parameters.
	2	A single degree of freedom system with mass 10 kg, stiffness 500 N/m and 5% damping is subjected to a load as shown in figure. Generate the displacement time history for t = 0 to t = 5 s.

		
CO5	1	A vibration isolation block, as shown in figure, is to be installed in a laboratory so that the vibration from adjadcent factory operations will not disturb certain experiments. If the isolation block weighs 1000 kg and the surrounding floor and foundation vibrates at 1500 cycles/minute, determine the stiffness of the isolation system such that the motion of the isolation block is limited to 25% of floor vibration. Assume damping as 12%. 
	2	A sensitive instrument of weight 30 kg is spring mounted on a floor which is vibrating harmonically with an amplitude of 0.5 mm at a frequency of 10 Hz. If the stiffness of the spring is 18 kN/m and damping is 10% of critical, find the amplitude of motion of the instrument.
CO6	1	Starting from fundamentals, find the natural frequencies and mode shapes of a simply supported beam of span L having uniform flexural rigidity EI and mass $\overline{m}$ per unit length. Sketch the mode shapes also.
	2	Formulate the equations for finding the natural frequencies for transverse vibrations of a cantilever beam.

24CEH729	ADVANCED SOIL MECHANICS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: This course intends to bridge the basic soil mechanics concepts with the advanced topics related to soil strength and volume change. The course covers foundational aspects of soil mechanics, providing a thorough understanding of soil structure, water interactions, seepage analysis, volume change behavior, strength characteristics, stress paths, and critical state soil mechanics. At the end of the course, students will be able to solve geotechnical problems using geo-mechanical concepts.

Prerequisite: 24CEJ502 Foundation Engineering

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

CO1	Explain soil water interaction problems and its effect on soil behaviour. (Understand Level)
CO2	Describe consolidation and swell phenomenon and apply it to various Geotechnical problems. (Apply Level)
CO3	Interpret the shear strength behavior of cohesion and cohesionless soil. (Apply Level)
CO4	Illustrate the stress path for drained and undrained soil. (Apply Level)
CO5	Discuss about critical state soil mechanics. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	-	-	-	-	-	-	-	-	-
CO2	3	1	2	-	-	-	-	-	-	-	-	-
CO3	3	1	1	-	-	-	-	-	-	-	-	-
CO4	3	-	3	-	-	-	-	-	-	-	-	-
CO5	3	-	1	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Soil -Water Interactions)

Soil structure: Fundamental Units - Silica tetrahedron, alumina octahedron, silica sheet, alumina sheet. Types of clay minerals: kaolinite, illite, montmorillonite – classification and identification – Clay mineral identification by XRD.

Types of water in soils - Mechanism of soil-water interactions - Its relevance to engineering behavior of soils.

Seepage Analysis: Seepage force, seepage pressure, quick condition – Liquefaction – Piping resistance of soil, Force equilibrium in seepage problems – Effective stress under steady seepage conditions – Two-dimensional flow – Laplace's equation – Flow net.

MODULE II (Volume Change Behaviour of Soils)

Compressibility of soils: consolidation theory (one, two, and three-dimensional consolidation theories), Stress history Pre-consolidation pressure, consolidation in

layered soil and consolidation for time-dependent loading, secondary compression – Radial consolidation.
Swelling: Problems associated with swelling and shrinkage behaviour of soils – Causes, consequences and mechanisms – factors influencing swell – shrink characteristics – swell potential – osmotic swell pressure – soil suction - measurement of suction and swell.

MODULE III (Strength Behavior of Soils)

Shear Strength of soils; Mohr Circle of Stress; unconsolidated undrained (UU), consolidated undrained (CU), consolidated drained (CD) tests, drained and undrained behavior of sand and clay, Pore water Pressure: significance of pore pressure parameters, Skempton's pore pressure coefficient, Determination of shear strength of soil, Interpretation of triaxial test results.

MODULE IV (Stress Path)

Stress path: Drained and undrained stress path, Stress path with respect to different initial state of the soil; Stress path for different practical situations.

MODULE V (Critical State Soil Mechanics)

Critical state soil mechanics: Critical state parameters, Critical state for normally consolidated and over consolidated soil, Significance of Roscoe and Hvorslev state boundary surface; drained and undrained plane, Critical void ratio; effect of dilation in sands; different dilation models.

Text books

1. Braja M. Das, Advanced Soil Mechanics, fifth edition (2019) New York: Taylor & Francis.
2. Atkinson, John. An introduction to the mechanics of soils and foundations: through critical state soil mechanics. McGraw-Hill Book Company (UK) Ltd, 1993.

Reference books

1. Srinath, L. S. Advanced mechanics of solids. Tata McGraw-Hill, 2003.
2. M.E. Harr, Foundations of Theoretical Soil Mechanics., McGraw-Hill, New York, [1966].
3. Holtz, Robert D., William D. Kovacs, and Thomas C. Sheahan. An introduction to geotechnical engineering. Vol. 733. Englewood Cliffs: Prentice-Hall, 1981.
4. Knappett, Jonathan, and Robert F. Craig. Craig's soil mechanics. CRC press, 2019.
5. Smith, Ian. Smith's elements of soil mechanics. John Wiley & Sons, 2021.
6. Wood, David Muir. Soil behaviour and critical state soil mechanics. Cambridge university press, 1990
7. Terzaghi, Karl, Ralph B. Peck, and Gholamreza Mesri. Soil mechanics engineering practice -CE3 practice
8. Lambe, T. William, and Robert V. Whitman. Soil mechanics. Vol. John Wiley

& Sons, 1991.
9. Mitchell, James Kenneth, and Kenichi Soga. Fundamentals of soil behavior. Vol. 3. New York: John Wiley & Sons, 2005.
10. Yong, R.N. and Warkentin, B.P., Introduction to Soil Behaviour, Macmillan, Limited, London, 1979.
11. Van Olphen, H. (1977) An Introduction to Clay Colloid Chemistry: For Clay Technologists, Geologists and Soil Scientists. 2nd Edition, Wiley, New York.
12. R. E. Grim: Clay Mineralogy. 2nd edition, McGraw-Hill Book Company, New York (1968).
13. Das, Braja M. Principles of geotechnical engineering. Cengage learning, 2021.
14. Donald Coduto, Man-chu Yeung, Man-chu Ronald Yeung, William Kitch. Geotechnical Engineering: Principles & Practices Edition: 2. Pearson City, ISBN: 0132368684.
15. McCarthy, David F, Essentials of soil mechanics and foundations: basic geotechnics Edition: 7th, intern. 2014, Pearson City, ISBN: 9781292039398.
16. Nagaraj, T. S., and B. R. Srinivasa. Analysis and prediction of soil behaviour. Taylor & Francis, 1994.

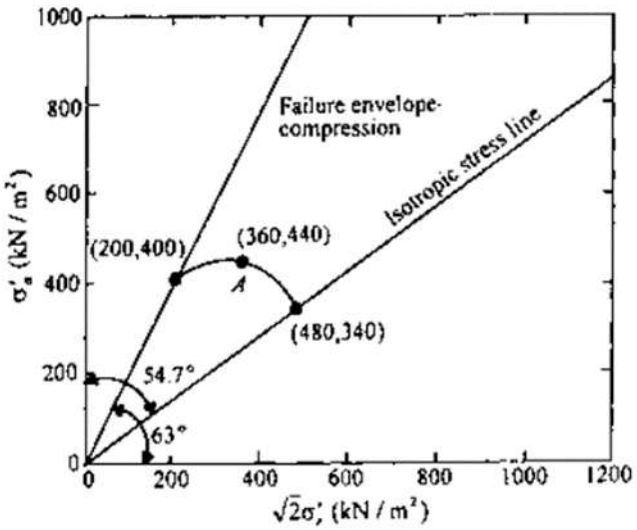
COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (48)
	MODULE 1 (10 hours)	
1.1	Soil structure – Fundamental units: Silica tetrahedron, alumina octahedron, silica sheet, alumina sheet. Types of clay minerals: kaolinite, illite, montmorillonite.	1
1.2	Types of clay minerals: kaolinite, illite, montmorillonite.	1
1.3	Classification and identification – Clay mineral identification by XRD.	1
1.4	Types of water in soils – mechanism of soil – water interactions – Its relevance to engineering behavior of soils.	1
1.5	Relevance of soil-water interaction in engineering behaviour of soil.	1
1.6	Seepage Analysis: Seepage force, seepage pressure, quick condition – Liquefaction.	1
1.7	Piping resistance of soil.	1
1.8	Force equilibrium in seepage problems.	1
1.9	Effective stress under steady seepage conditions Two-dimensional flow – Laplace's equation – Flow net.	1

1.10	Numerical Problem	1
MODULE II (10 hours)		
2.1	Compressibility of soils: consolidation theory (one, two, and three-dimensional consolidation theories)	1
2.2	Consolidation theory - three-dimensional consolidation theories.	1
2.3	Stress history Pre-consolidation pressure.	1
2.4	Consolidation in layered soil and consolidation for time dependent loading.	1
2.5	Secondary compression – Radial consolidation.	1
2.6	Swelling: Problems associated with swelling and shrinkage behaviour of soils.	1
2.7	Numerical Problem	1
2.8	Swelling: Causes, consequences and mechanisms.	1
2.9	Measurement of suction and swell.	1
2.10	Factors influencing swell – shrink characteristics – swell potential – osmotic swell pressure – soil suction.	1
MODULE III (9 hours)		
3.1	Shear Strength of soils; Mohr Circle of Stress.	1
3.2	Unconsolidated undrained test.	1
3.3	Consolidated undrained test & Consolidated drained tests.	1
3.4	Drained and undrained behavior of sand.	1
3.5	Drained and undrained behavior of clay.	1
3.6	Pore water Pressure: significance of pore pressure parameters, Skempton's pore pressure coefficients.	1
3.7	Numerical problems.	1
3.8	Determination of shear strength of soil.	1
3.9	Interpretation of triaxial test results.	1
MODULE IV (10 hours)		
4.1	Stress path: Drained stress path.	1

4.2	Stress path: Undrained stress path.	1
4.3	Numerical problems.	1
4.4	Stress path with respect to different initial state of the soil.	1
4.5	Stress path with respect to different initial state of the soil.	1
4.6	Stress path with respect to different initial state of the soil.	1
4.7	Stress path with respect to different initial state of the soil.	1
4.8	Stress path for different practical situation.	1
4.9	Stress path for different practical situation.	1
4.10	Stress path for different practical situation.	1
MODULE V (9 hours)		
5.1	Critical state soil mechanics: Critical state parameters.	1
5.2	Critical state soil mechanics: Critical state parameters.	1
5.3	Critical state soil mechanics: Critical state parameters.	1
5.4	Critical state for normally consolidated soil.	1
5.5	Critical state for over consolidated soil.	1
5.6	Significance of Roscoe and Hvorslev state boundary surface; drained plane.	1
5.7	Significance of Roscoe and Hvorslev state boundary surface; undrained plane.	1
5.8	Critical void ratio; effect of dilation in sands.	1
5.9	Different dilation models.	1

CO Assessment Questions	
CO1	1. Discuss about 'base exchange capacity'? List the cations in order of their increasing replacement power. What is the significance of cation exchange? 2. Explain Skempton Pore pressure coefficients A and B.
CO2	1. Discuss about the effect of secondary consolidation on pre consolidation pressure. 2. The average effective overburden pressure on a 10-m-thick clay layer in the field is 136 kN/m2, and the average void ratio is 0.98. If a uniform surcharge of 200 kN/m2 is applied on the ground surface, determine the consolidation settlement for the following cases, given Cc = 0.35 and Cr = 0.08:(a) Pre consolidation pressure, σ_c' = 350 kN/m^2 (b) σc' = 200 kN/m2.
CO3	1. Discuss the factors affecting shear strength of cohesive and cohesion less soils. 2. In a triaxial test, a soil sample was consolidated under a cell pressure of 700 kN/m^2 and a back pressure of 350 kN/m^2. Thereafter with drainage not allowed, the cell pressure was raised to 800 kN/m^2 resulting in the increased pore water pressure reading of 445 kN/m^2. The axial load was then increased to give a deviator stress of 575 kN/m^2 (while the cell pressure remained at 800 kN/m2) and a pore pressure reading of 640 kN/m^2. Calculate pore pressure coefficients.
CO4	1. Name the basic stress path used in practice. If the inclination of the p-q plot is 25° to the horizontal, find the value of the angle of the shearing resistance of the soil 2. The stress path for a normally consolidated clay is shown in the Figure 3. (Rendulic plot). The stress path is for a consolidated undrained triaxial test where failure was caused by increasing the axial stress while keeping the radial stress constant. Determine a) Φ for the soil (b) The pore water pressure induced at A, (c) The pore water pressure at failure, and (d) The value of A_f.

	
CO5	1. Explain the significance of Roscoe and Hvorslev state boundary surface for a critical state. 2. Explain about the critical state for over consolidated soil.

24CEH739	HYDROINFORMATICS	L	T	P	J	S	C	Year of Introduction
		4	0	0	0		4	2024

Preamble: The syllabus encompasses a comprehensive exploration of data collection, interpretation, and modeling in the field of hydroinformatics. It delves into critical topics such as data types, metadata, geospatial models, statistical data mining, artificial neural networks, and fuzzy logic, all within the context of hydrology and GIS. Students will gain a deep understanding of the tools, techniques, and models essential for addressing complex hydrological and environmental challenges through the integration of data science and geospatial technologies.

Prerequisite: Nil

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Explain the techniques and tools in information technology for rapid hydrologic information analysis and modelling. (Understand Level)
CO2	Identify the various aspects associated with spatial data modelling for modelling in Water resources. (Understand Level)
CO3	Explain the concepts in integration of Hydrologic and GIS models. (Understand Level)
CO4	Describe the various the data mining methods for modelling Hydro informatics. (Understand Level)
CO5	Comprehend the concept of linguistic variables and their significance in modeling imprecise information within a fuzzy set framework. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	2	1	-	-	-	-	-	-	-
CO4	3	2	-	2	1	-	-	-	-	-	-	-
CO5	2	2	-	2	1	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
4-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS
Module I (Data Collection)
Issues in data collection and interpretation - scale triplet - Sampling frequency, smoothing of data, Data loggers. Data and Data Life cycle: Data Types - Classification, Format, media and storage of data – Data Life Cycle - Components. Meta data, metamodal, meta-metamodel - Functional types of metadata, standardization – Observations data Model; Spatial hydrologic data models : Data models : Entities, attributes, relationships, business rules, Cardinality.

Data model design - relational data model design - Data file formats, file access, file structure Designing file formats - application programming interfaces.

Module II (Data Modelling)

Geodata model: structure of geodatabase - Arc Hydro data model.

Modelshed Geodata model - model shed, structure-modelling of fluxes modelshed links, area link, and orthogonal link.

Dynamic modelshed features, linkage with flux - applications – Open GIS concepts.

Integration of Hydrologic and GIS models – Coupling - loose and rigid type, Embedding types – Example.

Module III (Data Analysis)

Statistical data mining - Supervised Learning – Classification and Regression: Linear Models, Generalized linear models (GLMs) – Logistic Regression, Poisson Regression, Gamma and Exponential GLMs.

k-Nearest Neighbors (kNN), Polynomial regression and Generalized additive models, Kernel-based methods.

Decision trees - Classification and Regression Trees (CART) - Support Vector Machines (SVM) – Applications.

Unsupervised learning : Cluster analysis - Hierarchical clustering, Hard (k mean) clustering and Fuzzy clustering (fuzzy c-means), Application.

Module IV (ANN)

Artificial Neural Networks: concepts, architecture, types, transfer functions, training algorithms. Back propagation neural networks, RBF networks, Recurrent networks.

Deep learning networks, concepts, types.

Application in Hydro informatics.

Module V (Fuzzy Logic)

Fuzzy sets: Fuzzy set - Fuzziness Vs randomness - types of uncertainty linguistic variables and inference rules - membership functions.

Basic operations - Fuzzy relation - max-min, max-product composition.

Fuzzy logic, fuzzy reasoning, fuzzy logic model formulation, inference system, Fuzzification and defuzzification.

Hydro informatics application.

Text Books:

1. “Hydroinformatics and Hydro-GIS" by N.C. Ghosh.
2. "Geospatial Technologies in Environmental Management" by Jayant Sharma.
3. "Statistical Data Mining and Knowledge Discovery" by Anil Kumar and Anand Rajavat.
4. "Artificial Neural Networks and Deep Learning" by Kagan Tumer and Ahmet Yilmaz.
5. "Fuzzy Logic and Applications" by Madan M. Gupta and Nirupama Gupta.

Reference Books:

1. Dimitri P Solomatine, and Linda M See (2008), Practical Hydroinformatics Computational Intelligence and Technological developments in water applications, Springer, Berlin.
2. Robert Nisbet, Gary Miner, Ken Yale (2018). Hand book of statistical analysis and data mining applications. Academic Press.
3. Praveen Kumar, Jay Alameda, Peter Bajcsy, Mike Folk and Momcil Markus, (2006) Hydroinformatics :Data Integrative Approaches in Computation, Analysis and

Modelling, Taylor and Francis, 2006.
4. Robert J Abrahart, Linda M See, Dimitri P Solomatine (2008), Practical Hydroinformatics, WSTL Vol. 68, Springer.
5. Taesam Lee, Vijay P Singh, Kyung Hwa Cho (2021) Deep Learning for Hydrometeorology and Environmental science, WSTL 99, Springer.
6. Simon Haykin (2005) Neural Networks Pearson Prentice Hall.
7. Bruce ratner (2017) Statistical and machine learning data mining, CRC Press, 3rd ed.
8. Ross T J (2002) Fuzzy logic with Engineering Applications, Mc Graw Hill, NY, 1995.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hour (48)
Module I (8 Hours)		
1.1	Issues in data collection and interpretation - scale triplet.	1
1.2	Sampling frequency, smoothing of data, Data loggers.	1
1.3	Data and Data Life cycle: Data Types – Classification.	1
1.4	Format, media and storage of data – Data Life Cycle - Components.	1
1.5	Meta data, metamodal, meta-metamodel;	1
1.6	Functional types of metadata, standardization – Observations data Model.	1
1.7	Spatial hydrologic data models: Data models: Entities, attributes.	1
1.8	Relationships, business rules, Cardinality.	1
1.9	Data model design - relational data model design - Data file formats, file access, file structure.	1
1.10	Designing file formats - application programming interfaces.	1
Module II (8 Hours)		
2.1	Geodata model: structure of geodatabase - Arc Hydro data model.	1
2.2	Modelshed Geodata model - model shed.	1
2.3	Structure - modelling of fluxes - modelshed links.	1

2.4	Area link, orthogonal link.	1
2.5	Dynamic modelshed features, linkage with flux - applications.	1
2.6	Open GIS concepts.	1
2.7	Integration of Hydrologic and GIS models – Coupling - loose and rigid type.	1
2.8	Embedding types – Example.	1
Module III (11 Hours)		
3.1	Statistical data mining- Supervised Learning.	1
3.2	Classification and Regression: Linear Models, Generalized linear models (GLMs).	1
3.3	Logistic Regression, Poisson Regression.	1
3.4	Gamma and Exponential GLMs.	1
3.5	k-Nearest Neighbors (kNN).	1
3.6	Polynomial regression and Generalized additive models.	1
3.7	Kernel-based methods.	1
3.8	Decision trees - Classification and Regression Trees (CART).	1
3.9	Support Vector Machines (SVM) – Applications.	1
3.10	Unsupervised learning: Cluster analysis - Hierarchical clustering.	1
3.11	Hard (kmean) clustering and Fuzzy clustering (fuzzy c-means), Application.	1
Module IV (9 Hours)		
4.1	Artificial Neural Networks: concepts.	1
4.2	Architecture, types, transfer functions.	1
4.3	Training algorithms.	1
4.4	Back propagation neural networks.	1
4.5	RBF networks.	1
4.6	Recurrent networks.	1

4.7	Deep learning networks.	1
4.8	Concepts, types.	1
4.9	Application in Hydro informatics.	1
Module V (10 Hours)		
5.1	Fuzzy sets: Fuzzy set.	1
5.2	Fuzziness Vs randomness.	1
5.3	Types of uncertainty - linguistic variables.	1
5.4	Inference rules - membership functions.	1
5.5	Basic operations - Fuzzy relation.	1
5.6	Max-min, max-product composition.	1
5.7	Fuzzy logic, fuzzy reasoning.	1
5.8	Fuzzy logic model formulation, Inference system.	1
5.9	Fuzzification and defuzzification.	1
5.10	Hydro informatics application.	1

CO Assessment Questions	
CO1	1. Explain the effect of choice of scale, sampling frequency, and data smoothing techniques in the accuracy and reliability of data collected in hydrology. 2. In the context of hydrological data management, differentiate between various data types and their classification.
CO2	1. Explain the Arc Hydro data model structure in facilitating the representation of hydrological features within a geodatabase. Elaborate on the components and characteristics of the Modelshed Geodata model. 2. Explain the different integration methods, such as loose and rigid coupling as well as embedding types, providing an example to illustrate their application in combining hydrologic and GIS models for practical purposes.
CO3	Differentiate between Polynomial regression and Generalized additive models.
CO4	Explain about artificial neural networks.
CO5	Differentiate between fuzziness and randomness.

Semester 8

B.Tech (Civil Engineering) Curriculum – Semester 8

EIGHTH SEMESTER												Total Marks	
Sl No	Slot	Code	Category	Title	L	T	P	J	S	Hours	Credits	CIA	ESE
1	A	24CEE8X1	PEC	Professional Elective-4 / MOOC (Internship Students: MOOC Approved by the Institute/Online Classes)	3	0	0	0	3	3	3	40	60
2	B	24CEO8X2	OEC	Open Elective-2 / MOOC (Internship Students: MOOC Approved by the Institute/Online Classes)	3	0	0	0	3	3	3	40	60
3	C	24CEO8X3	OEC	Open Elective- 3/ MOOC (Internship Students: MOOC Approved by the Institute/Online Classes)	3	0	0	0	3	3	3	40	60
4	U	24CED804 / 24CEN804	PR/IP	PROJECT/ INTERNSHIP Option 1: : Major Project Phase -II (For the students who have not opted for internship in S8) Option 2: Internship (4-6 Months)	0	0	14	0	14	14	7	100	
5	H/R	24CEH809	PRH	Project in Honours/ Remedial	0	0	0	4			4/0	100	
TOTAL									**23**	**23**	**16**		

Semester VIII	PROFESSIONAL ELECTIVE IV	Micro Specialisation
CEE 811	ADVANCED STRUCTURAL DESIGN	Gr-I
CEE 821	BRIDGE ENGINEERING	Gr-I
CEE 841	CONSTRUCTION PLANNING AND MANAGEMENT	Gr-II
CEE 851	GROUND IMPROVEMENT TECHNIQUES	Gr-III

CEE 861	GEOENVIRONMENTAL ENGINEERING	Gr-III
CEE 871	HYDROCLIMATOLOGY	Gr-IV
CEE 881	IRRIGATION AND DRAINAGE ENGINEERING	Gr-IV
CEE 891	SOLID WASTE MANAGEMENT	Gr-V
CEE 8101	AIR QUALITY MANAGEMENT	Gr-V
CEE 8111	HIGHWAY MATERIALS AND DESIGN	Gr-VI
CEE 8121	MULTI MODAL URBAN TRANSPORTATION SYSTEMS	Gr-VI

Semester VIII OPEN ELECTIVE II

24CEO812	REMOTE SENSING AND GIS
24CEO822	SOIL AND WATER CONSERVATION ENGINEERING
24CEO832	MODERN CONSTRUCTION MATERIALS

Semester VIII OPEN ELECTIVE III

24CEO813	DISASTER PREPAREDNESS AND MANAGEMENT
24CEO823	VIBRATION ENGINEERING
24CEO833	INTELLIGENT TRANSPORTATION SYSTEM
24CEO843	SOLID WASTE MANAGEMENT

HONOURS					
BASKET 1		**BASKET 2**		**BASKET 3**	
STRUCTURAL ENGINEERING AND CONSTRUCTION MANAGEMENT		**TRANSPORTATION AND GEOTECHNICAL ENGINEERING**		**WATER RESOURCES AND ENVIRONMENTAL ENGINEERING**	
24CEH819	MINI PROJECT	24CEH829	MINI PROJECT	24CEH839	MINI PROJECT

PROFESSIONAL ELECTIVE – 4

24CEE811	ADVANCED STRUCTURAL DESIGN	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to provide an in-depth understanding of the behavior and design principles for reinforced concrete structures. The course encompasses advanced topics in structural engineering, such as design of continuous beam, flat slab, foundation, retaining walls and water tanks. After the completion of this course, students acquire knowledge and skills necessary to analyze and design structures made of reinforced concrete.

Prerequisite: 24CEP504 Design of Structures I

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

CO1	Design continuous beam and beam column joints. (Apply and Analyse Level)
CO2	Apply IS code provision for the design and detailing of flat slab. (Apply and Analyse Level)
CO3	Design continuous footing, pile and pile cap. (Apply and Analyse Level)
CO4	Design retaining wall. (Apply and Analyse Level)
CO5	Design water tank. (Apply and Analyse Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	-	-	-	-	-	-	2
CO2	3	3	3	-	-	-	-	-	-	-	-	2
CO3	3	3	3	-	-	-	-	-	-	-	-	2
CO4	3	3	3	-	-	-	-	-	-	-	-	2
CO5	3	3	3	-	-	-	-	-	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember				
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse	✓	✓	✓	✓
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L-T]			Total Marks
		Assignment	Test-1	Test-2	
4-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Design of Continuous Beam)

Design of continuous beams - Redistribution of moments, RCC beam-column joints - classification - shear strength - design of exterior and interior joints.

MODULE II (Design of Flat Slabs)

Design of flat slabs - Introduction, components - IS Code recommendations, IS code method of design, with and without drop, interior and exterior panels.

MODULE III (Design of Foundations)

Combined Footing - Rectangular, Trapezoidal. Design concepts of Pile foundation: Pile and Pile cap design of end bearing piles.

MODULE IV (Design of Retaining Walls)

Retaining walls - Types - Cantilever retaining wall - earth pressure and forces acting - stability - proportioning - structural behavior of components - design example of cantilever retaining wall - detailing. Counterfort retaining wall - design principles of components and detailing (design not required).

MODULE V (Design of Water tanks)

Introduction to design of water tanks - design philosophy and requirements - joints - IS code recommendations. Design of rectangular water tanks using IS 3370: 2009. Design of circular water tanks using IS 3370: 2009.

Text Books:

1. S. S. Bhavikatti, “Advanced R.C.C. Design Vol. II”, New Age International Private Limited.
2. B. C. Punmia, Ashok K Jain, Arun K Jain, “Reinforced Concrete Vol. II”, Lakshmi Publications.

3. S. Unnikrishna Pillai, Devadas Menon, “Reinforced Concrete Design”, Tata McGraw-Hill Publishing Company Ltd.
4. N. Krishna Raju., “Design of Reinforced Concrete Structures”, CBS Publishers and Distributors.

Reference Books:

1. IS: 456 - 2000, SP 16 : 1980, SP: 24 (S&T) - 1983, SP 34 : 1987, IS 3370 : 2009.
2. IS: 875 : 1987 - (Part I to V) - “Code of practice for structural safety of building loading standards”.
3. P. C. Varghese, “Foundation Engineering”, Prentice Hall of India Private Ltd.
4. S. Ramamrutham, “Design of Reinforced Concrete Structures”, Dhanpat Rai Publishing Company.
5. P. C. Varghese, “Limit State Design of concrete structures”, Prentice Hall of India Private Ltd.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hour (36)
Module I (7 Hours)		
1.1	Introduction - Continuous beams.	1
1.2	Design of continuous beams - IS code provisions.	1
1.3	Moment redistribution in continuous beam.	1
1.4	Introduction - RCC beam & column joints – Classification.	1
1.5	Concept of shear strength.	1
1.6	Design of exterior joints.	1
1.7	Design of interior joints.	1
Module II (8 Hours)		
2.1	Introduction & components - Flat slab.	1
2.2	Design of flat slab - IS Code recommendations.	1
2.3	Design of flat slab - IS code method of design.	1
2.4	Design concepts of flat slab with and without drop.	1
2.5	Interior panel design with drop – Numericals.	1
2.6	Exterior panel design with drop – Numericals.	1
2.7	Interior panel design without drop – Numericals.	1
2.8	Exterior panel design without drop – Numericals.	1
Module III (8 Hours)		
3.1	Theory and design - Isolated & combined footing.	1
3.2	Isolated footing - Square footing – Numericals.	1
3.3	Isolated footing - Rectangular footing – Numericals.	1
3.4	Combined footing - Rectangular footing – Numericals.	1
3.5	Combined footing - Trapezoidal footing – Numericals.	1
3.6	Pile foundation - Design concepts.	1

3.7	Pile foundations – Numericals.	1
3.8	Pile cap with end bearing piles – Numericals.	1
Module IV (9 Hours)		
4.1	Introduction & Types of retaining walls.	1
4.2	Concept of earth pressure & forces acting - Cantilever retaining wall.	1
4.3	Analysis of stability, proportioning, structural behavior of components - Cantilever retaining wall.	1
4.4	Design concepts - Cantilever retaining wall.	1
4.5	Cantilever retaining wall – Numericals.	1
4.6	Design principles of components and detailing - Counterfort retaining wall.	1
4.7	Design principles of components and detailing - Counterfort retaining wall.	1
Module V (10 Hours)		
5.1	Introduction & design philosophy - water tanks - Requirements – joints.	1
5.2	IS code recommendations.	1
5.3	Design concept of rectangular water tanks - IS 3370: 2009.	1
5.4	Design of rectangular water tanks - IS 3370: 2009.	1
5.5	Design concept of circular water tanks using - IS 3370: 2009.	1
5.6	Design of circular water tanks using - IS 3370: 2009.	1

CO Assessment Questions	
CO1	Design a continuous beam of two spans supported on stone masonry walls using the limit state method and allowing 15% redistribution of moments. The following data may be assumed - clear span between the supports = 6 m, width of masonry supports = 330 mm, thickness of RC slab = 150 mm, spacing of continuous beams = 3m c/c, self-weight of floor finish = 0.4 kN/m^2, LL on the floor = 4 kN/m^2, characteristic cube strength of concrete = 20 N/mm^2 and characteristic strength of steel = 415 N/mm^2.
CO2	1. Discuss the following: i) Applications of flat slab ii) Components of flat slab. 2. Design an interior panel of a flat slab with panel size 6 m x 6 m by providing drop. The size of columns is (500 x 500) mm and live load on the panel is 4 KN/m^2. Use M20 grade concrete and Fe 415 steel.
CO3	1. Discuss the design procedure of a pile cap. 2. Design a pile foundation under a column transmitting a load of 800 kN. The pile is to be driven in to hard stratum available at a depth of 12 m. Use M20 concrete and Fe 415 steel.
CO4	1. Explain different types of retaining walls with neat sketches. Identify the situations in which each type of retaining wall is used. 2. A cantilever retaining wall is designed to retain earth for a height of 4.4 m. The safe bearing capacity of soil is 200 kN/m^2 and unit weight of soil is

	17.5 kN/m^3. Coefficient of friction between soil and concrete is 0.55. Proportion the retaining wall and check for stability. Also design and detail the heel and toe slab of the retaining wall.
CO5	Design a circular water tank with fixed base, resting on ground, to store 450 m^3 of water. Use M30 concrete and Fe 415 steel. Draw the cross section of water tank showing reinforcement details.

24CEE821	BRIDGE ENGINEERING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course provides a comprehensive understanding on the fundamentals of bridge engineering. It includes various topics such as selection and planning, structural configurations, structural actions and design aspects of different types of bridges, assessment of loads and design of various components of reinforced concrete and steel bridges. After the completion of the course the student will gain insights and skills for deign of various bridge structures while adhering to codal provisions.

Prerequisite: 24CEP504 Design of structures I, 24CEJ602 Design of structures II

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

CO1	Discuss the codal provisions for road and rail bridges. (Understand Level)
CO2	Explain the design aspects of different types of bridges. (Understand Level)
CO3	Analyze, design and detail Slab bridges and T-Beam bridges for the given loading. (Apply Level)
CO4	Analyze and design Steel Truss Bridges and Plate girder bridges. (Apply Level)
CO5	Design Elastomeric bearings. (Apply Level) .
CO6	Discuss the design aspects of various Substructure elements of the RC Bridges. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	-	-	-	-	-	-	-	-
CO5	3	3	3	-	-	-	-	-	-	-	-	-
CO6	3	2	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Introduction and Codal Provisions for Bridges)

Introduction - Components of bridge, Classification of bridges, Site selection - Soil Exploration for site - Hydraulic factors in Bridge Design.

Basic Forms of bridges - Beam, Truss, Arch, Suspension, Cantilever and Cable-stayed bridges - Structural actions.

Standard specification for Road bridges: Width of carriageway – Clearances.

Loads to be considered - Dead load – I.R.C. standard live loads - Impact effect – Wind load – Longitudinal forces - Centrifugal forces - Horizontal forces due to water currents – Buoyancy effect - Earth pressure. (Problems not required)

Standard specification for Rail bridges – General features, IRS Rules on loads, equivalent uniformly distributed loads, other loads.

MODULE II (Slab Bridges and Box Culverts)

Solid slab bridges: Introduction, General design features, Effective width method. Simply supported Slab Bridge - analysis and design.

Box Culverts: Introduction to analysis, loading conditions, concept of design and detailing, (detailed design not expected)

MODULE III (T-Beam and Slab Bridges)

Beam and slab bridges: Introduction, Design of interior panel of slab. Pigeaud's method.

Calculation of longitudinal moment: Courbon's theory, Design of longitudinal girder, design example and Reinforcement detailing.

MODULE IV (Steel Bridges and Other Bridge Forms)

Steel Truss bridges - Design Principles - Design example.

Plate Girder bridges – Design of girders without stiffener and with end stiffener only.

Concepts on design of pre-stressed concrete bridges, Composite bridges - general features - shear connectors - types – functions.

Concepts on design of Rigid frame bridges, Balanced cantilever bridges, Continuous girder bridges.

MODULE V (Bearings and Substructures)

Bridge bearings: forces on bearings, basics for selection of bearings, design of elastomeric bearings.

Substructures: Abutments and piers - types, forces acting, stability requirements (designs not included).

Types of foundations, well foundation – open well foundation, components of well foundation, pile foundations (designs not included).

Text books

1. Jagadish T.R. & M.A. Jayaram, "Design of Bridge Structures", 2nd Edition, PHI learning, 2009.
2. Johnson Victor D, "Essentials of Bridge Engineering", 7th Edition, Oxford, IBH Publishing Co. Ltd., 2006.
3. Krishna Raju N., "Design of Bridges", 4th Edition, Oxford and IBH Publishing Co., Ltd., 2008.
4. Nagarajan P, Design of Concrete Bridges, Wiley Publications, 2020.
5. Duggal S.K., Limit state Design of Steel Structures, Tata McGraw Hill, New Delhi, 2010.
6. Bhavikkatti S.S., Design of Steel Structures, I K International Publishing House (P) Ltd., 2009.

Reference books

1. Ponnu Swamy, "Bridge Engineering", 4th Edition, McGraw-Hill Publication, 2008.
2. Swami Saran, "Analysis and Design of sub-structures",2nd Edition, Oxford IBH Publishing Co. Ltd., 2006.
3. Vazirani, Ratvani & Aswani, "Design of Concrete Bridges",5th Edition, Khanna Publishers, 2006.
4. Subramanian N., Design of Steel Structures, Oxford University Press, 2008.
5. IRC 5 :2015, IRC 6 :2014, IRC 112 :2011, IRC 83:2018.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36)
MODULE I (8 Hours)		
1.1	Introduction - Components of bridge.	1
1.2	Classification of bridge, Site selection - Soil Exploration for site - Hydraulic factors in Bridge Design.	1
1.3	Basic Forms of bridges - Beam, Truss, Arch bridges - Structural actions.	1
1.4	Suspension, Cantilever and Cable-stayed bridges - Structural actions.	1
1.5	Standard specification for Road bridges: Width of carriageway - Clearances as per IRC 5.	1
1.6	Loads to be considered - Dead load, I.R.C. standard live loads - Impact effect as per IRC 6.	1
1.7	Wind load – Longitudinal forces - Centrifugal forces - Horizontal forces due to water currents – Buoyancy effect - Earth pressure.	1
1.8	Standard specification for Rail bridges – General features, IRS Rules on loads, equivalent uniformly distributed loads, other loads.	1
MODULE II (7 Hours)		
2.1	Solid slab bridges: Introduction, General design features, Effective width method.	1
2.2	Simply supported and cantilever Slab Bridge – concepts.	1
2.3	Analysis and design of slab bridges – examples.	1
2.4	Analysis and design of slab bridges – examples.	1
2.5	Analysis and design of slab bridges – examples.	1
2.6	Box Culverts: Introduction to analysis.	1
2.7	Loading conditions, design and detailing – concept.	1
MODULE III (7 Hours)		
3.1	Beam and slab bridges: Introduction.	1
3.2	Design of interior panel of slab. Pigeaud's method.	1
3.3	Analysis and design of interior panel of slab – examples.	1

3.4	Analysis and design of interior panel of slab – examples.	1
3.5	Calculation of longitudinal moment: Courbon's theory.	1
3.6	Design of longitudinal girder – numerical examples.	1
3.7	Design example and Reinforcement detailing.	1
MODULE IV (7 Hours)		
4.1	Steel Truss bridges- Design Principles.	1
4.2	Design example.	1
4.3	Plate Girder bridges –Design principles.	1
4.4	Design example without stiffeners and with en stiffener only.	1
4.5	Pre-stressed concrete bridges.	1
4.6	Composite bridges, Rigid frame bridges.	1
4.7	Balanced cantilever bridges, Continuous girder bridges.	1
MODULE V (7 Hours)		
5.1	Bridge bearings: introduction, Forces on bearings, basics for selection of bearings.	1
5.2	Design of elastomeric bearings.	1
5.3	Numerical examples.	1
5.4	Substructures: Abutments - types, forces acting, stability requirements.	1
5.5	Piers - types, forces acting, stability requirements.	1
5.6	Types of foundations, well foundation–open well foundation Components of well foundation.	1
5.7	Pile foundations.	1

CO Assessment Questions	
CO1	1. Explain the longitudinal forces acting on bridges. 2. Define the term 'width of carriage way'. Explain the codal provisions regarding width of carriage way.

CO2	1. Describe the design principles of box culverts by incorporating the various loading combinations. 2. Discuss the design principles of a prestressed concrete bridge with neat sketches.
CO3	1. Design a solid slab bridge with the following data: i) Clear span = 7 m, ii) Carriageway width = 7.5 m, iii) Live load = IRC Class AA Tracked vehicle, iv) Mix M25 concrete and steel Fe 415, v) Average thickness of wearing coat = 70 mm. vi) Kerbs provided on both sides of the bridge is having a width of 600 mm. Provide the details of reinforcements with the help of a neat sketch. 2. Design the intermediate longitudinal girder of a T beam and slab bridge for the following data: Effective span = 12 m Carriage way width = 7m. Kerb = 600mm width on either side Loading = IRC Class A vehicle Adopt M25 concrete and Fe 415 grade steel. Provide three longitudinal beams. Shear check is not required.
CO4	1. Design a welded plate girder of span 24 m to carry a superimposed load of 35 kN/m. Avoid use of bearing and intermediate stiffeners. 2. Design a steel trussed bridge to suit the following data. Effective span – 30m Road way – 7.5m Kerbs – 600mm Loading - IRC Class AA tracked vehicle Materials : M25 concrete and Fe 415 grade steel for deck slab Rolled steel sections with an yield stress of 250N/mm^2
CO5	Design an elastomeric bearing for the following data: Reaction due to dead load (DL) and wearing coat = 540kN Reaction due to live load=1040kN Vertical reaction due to other horizontal forces = 40kN Horizontal forces in longitudinal direction = 60kN Horizontal forces in transverse direction = 80kN Rotation about transverse axis =0.006 radians Rotation about longitudinal axis =0 radian Horizontal displacement in longitudinal direction = 10 mm Horizontal displacement in transverse direction = 3 mm Width of flange of longitudinal girder = 500 mm.
CO6	1. Explain the forces to be considered during the design of piers and abutments? 2. Discuss about the stability analysis of abutments. 3. With neat sketch, explain well foundation and its components.

24CEE841	CONSTRUCTION PLANNING AND MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: Construction Planning and Management is a course designed to provide in-depth knowledge in the planning and management of construction projects. The course details the various operations encountered throughout the lifecycle of a construction project, from planning, tendering, and the management of human resources, materials, quality and safety in construction and operations. The course helps the students to develop the required skills to plan and manage various types of construction projects effectively.

Prerequisite: Nil

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

CO1	Describe the various phases in the planning of construction projects. (Understand Level)
CO2	Explain the process of bidding and awarding of construction contracts. (Understand Level)
CO3	Compare and contrast the various PPP models and describe the importance of risk allocation in the projects. (Understand Level)
CO4	Explain the management of human resources and materials as per the requirement of each project or site. (Understand Level)
CO5	Discuss the need for quality and safety management in construction. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	2	-	-	-	-	2	-
CO2	2	-	-	-	-	2	-	-	-	-	2	-
CO3	2	-	-	-	-	-	-	-	-	-	2	-
CO4	2	-	-	-	-	-	-	-	-	-	3	-
CO5	2	-	-	-	-	2	-	-	-	-	1	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern:

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Life Cycle of a Construction Project)

Construction Projects – Concepts – Types.

Life Cycle of a Construction Project – Pre-Project Phase, Project Phase, Post-Project Phase.

Pre-Project Phase – Project identification – Purpose and need for Project Identification – Methodology and steps in Project Identification – Project Feasibility – Introduction and need for Feasibility studies – Components – Market, Technical, Environmental, Financial feasibility analysis – Pre-feasibility Report and its Clearance – Preparation of Detailed Project Report (DPR) – Case studies – Different Project Clearances required.

MODULE II (Tenders and Contracts)

Tenders – Tendering process – Notice inviting tender – Pre-qualification of bidders – Evaluation of bids – E-Tendering/ Electronic Process – Unbalancing of tenders.

Contracts – Types of Contracts and their features – Contract documents – Contract

conditions and specifications – Variations and changes in contracts – Differing site conditions – Cost escalation – Delays, Suspensions & Terminations – Time extensions & Force Majeure – Delay Analysis – Liquidated damages & Penalties – Insurance & Taxation – Performance and Excusable Non-performance – Conventional and Alternative Dispute Resolution methods.

MODULE III (Public Private Partnership (PPP) Projects)

Private sector participation in Infrastructure Development Projects – Public Private Partnership (PPP) Projects – Characteristics – Limitations.

Models of PPP - Operation-maintenance, Lease, Concession (BOT, BOLT, BOOT), Private Finance Initiative – Basic structure of a PPP model – Financing of PPP projects.

Risk analysis and Management – Risk identification in PPP projects – Main categories – Mitigation measures – Allocation of risk to parties.

MODULE IV (Human Resource and Materials Management)

Human Resource Management – Manpower planning process – Organising, staffing, directing and controlling – Estimation of manpower requirement – Recruitment – Selection strategies – Placement and Training.

Materials Management – Importance – Need for an integrated concept – Inventory management – Types of inventory – Inventory Control – Costs associated with inventory – Economic Order Quantity – ABC Analysis.

MODULE V (Construction Quality and Safety Management)

Construction Quality Management – Construction quality – Inspection, Quality control and Quality assurance in projects – Preparation of quality manuals, check list and inspection report – Quality standards/ codes in design and construction – Basics of statistical quality control – Six Sigma – Importance, limitations and process of six sigma – Concept and philosophy of Total Quality Management (Brief description only).

Construction Safety Management – Causes of Accidents – Unsafe Conditions and Unsafe acts – Concept, Principles of safety – Factors affecting safety – Physiological, Psychological and Technological – Planning for safety provisions – Structural safety, safety consideration during construction, demolition and during use of equipment – Roles of Safety Personnel – Training for safety awareness and implementation – Formulation of safety manuals, safety legislation, standards, codes with regard to construction.

Text books

1) Kumar Neeraj Jha, Construction Project Management, 2nd ed. Pearson, Dorling Kindersley (India) Pvt. Ltd, 2015.
2) K. K. Chitkara, Construction Project Management Planning Scheduling & Controlling, Tata McGraw Hill, New Delhi, 2014.

Reference books

1) Frederick E. Gould, Managing the Construction Process: Estimating, Scheduling, and Project Control, Pearson, 2013.
2) Gupta, B. L. and Gupta, Amit. Construction Management, Machinery and

Accounts, 3rd ed. Standard Pub, 2005.
3) Loraine, R. K. Construction Management in Developing Countries. Thomas Telford, London, 1993.
4) Singh, Harpal. Construction Management and Accounts 14th ed. Tata McGraw-Hill Pub., New Delhi, 1981.
5) Kwaku A. Tenah, Jose M. Guevara. Fundamentals of Construction Management and Organisation. Reston Publishing Co. Inc., A Prentice Hall Company, Virginia, 1985.
6) Gould, E. Frederick and Joyce, E. Nancy. Construction Project Management. Prentice Hall, New Jersey, 2000.
7) B. Sengupta and H. Guha. Construction Management and Planning, Tata McGraw Hill, New Delhi, 1995.
8) Keith Collier. Construction Contracts, Merrill/Prentice Hall, 2009.
9) Patil, B. S. Building and Engineering Contracts, S.B. Patil Publications, Pune, 2011.
10) John Murdoch & Will Hughes. Construction Contracts - Law and Management, Spon Press, Taylor & Francis Group, 2008.
11) J. R. Tony Arnold, Stephen N. Chapman, Llyod M. Clive. Introduction to Materials Management, 6th edition, Pearson Education Inc., 2008.
12) A. K. Datta. Materials Management: Procedures, Text and Cases, 2nd edition, PHI Learning Pvt. Ltd., 2012.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topic	No. of Hours (36)
	MODULE 1 (7 Hours)	
1.1	Construction Projects – Concepts – Types.	1
1.2	Life Cycle of a Construction Project – Pre-Project Phase, Project Phase, Post-Project Phase.	1
1.3	Project identification – Purpose and need for Project Identification – Methodology and steps in Project Identification.	1
1.4	Introduction and need for Feasibility studies, Components – Market, Technical, Environmental, Financial feasibility analysis.	1
1.5	Pre-feasibility Report and its Clearance.	1
1.6	Preparation of Detailed Project Report (DPR) – Case studies.	1
1.7	Different Project Clearances required.	1
	MODULE II (8 Hours)	
2.1	Tenders – Tendering process – Notice inviting tender.	1

2.2	Pre-qualification of bidders.	1
2.3	Evaluation of bids, E-Tendering/ Electronic Process, Unbalancing of tenders.	1
2.4	Contracts – Types of Contracts and their features.	1
2.5	Contract documents – Contract conditions and specifications.	1
2.6	Variations and changes in contracts – Differing site conditions, Cost escalation, Delays, Suspensions & Terminations.	1
2.7	Time extensions & Force Majeure, Delay Analysis, Liquidated damages & Penalties, Insurance & Taxation, Performance and Excusable Non-performance.	1
2.8	Conventional and Alternative Dispute Resolution methods.	1
MODULE III (6 Hours)		
3.1	Private sector participation in Infrastructure Development Projects, Public Private Partnership (PPP) Projects – Characteristics – Limitations.	1
3.2	Models of PPP – operation-maintenance, lease.	1
3.3	Concession (BOT, BOLT, BOOT).	1
3.4	Private Finance Initiative, Basic structure of a PPP model, Financing of PPP projects.	1
3.5	Risk identification in PPP projects – Main categories.	1
3.6	Mitigation measures – Allocation of risk to parties.	1
MODULE IV (7 Hours)		
4.1	Manpower planning process – Organising, staffing, directing and controlling.	1
4.2	Estimation of manpower requirement, Recruitment.	1
4.3	Selection strategies, Placement and Training.	1
4.4	Materials Management – Importance, Need for an integrated concept.	1
4.5	Inventory management – Types of inventory – Inventory Control – Costs associated with inventory.	1
4.6	Economic Order Quantity.	1

4.7	ABC Analysis.	1
MODULE V (8 Hours)		
5.1	Construction quality, Inspection and Quality control in projects.	1
5.2	Quality assurance in projects, Preparation of quality manuals, check list and inspection report.	1
5.3	Quality standards/ codes in design and construction – Basics of statistical quality control.	1
5.4	Six Sigma – Importance, limitations and process of six sigma Concept and philosophy of Total Quality Management (Brief description only).	1
5.5	Construction Safety Management – Causes of Accidents, Unsafe Conditions and Unsafe acts.	1
5.6	Principles of safety, Factors affecting safety – Physiological, Psychological and Technological factors.	1
5.7	Planning for safety provisions – Structural safety, safety consideration during construction, demolition and during use of equipment.	1
5.8	Roles of Safety Personnel – Training for safety awareness and implementation – Formulation of safety manuals, safety legislation, standards, codes with regard to construction.	1

CO Assessment Questions	
CO1	Discuss the various types of feasibility studies to be undertaken in construction projects. Elucidate the importance of the feasibility study phase in determining the success of a construction project.
CO2	Describe the contents of a tender document. Enumerate the complete tendering procedure with illustrations.
CO3	Compare and contrast the concession and Private Finance Initiative models of PPP.
CO4	Explain the staffing process which leads up to selection of candidates.
CO5	Discuss inspection, quality control and quality assurance in a construction project.

24CEE851	GROUND IMPROVEMENT TECHNIQUES	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: Throughout this course, an understanding of various ground improvement methods will be instilled, allowing them to be classified based on soil suitability and applied to real-world scenarios. Fundamental concepts and design aspects of these techniques will be outlined, ensuring the intricacies involved are comprehended. Upon the completion of the course the student will be able to identify the appropriate ground improvement technique in diverse geotechnical contexts.

Prerequisite: 24CEJ502 Foundation Engineering

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

CO1	Classify different ground improvement methods based on the soil suitability. (Understand and Apply Level)
CO 2	Outline the basic concept/ design aspects of various ground improvement methods. (Understand Level)
CO 3	Explain the procedure of different ground improvement methods. (Understand)
CO 4	Describe different applications of geosynthetics and soil stabilization in Ground improvement. (Understand Level)
CO 5	Describe emerging ground improvement techniques for applications in diverse geotechnical contexts. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-
CO 4	2	2	-	-	-	-	-	-	-	-	-	-
CO 5	2	2	-	-	-	-	-	-	-	3	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓		✓	✓
Analyze				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hrs

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Introduction)

Need for ground improvement, Classification of ground improvement techniques, factors affecting its choice, objectives, Ground improvement potential.
Excavation and replacement - numerical problems.
Problematic soils - expansive soils, collapsible soils, soft clays.
Shear strength of soil - frictional strength, cohesive strength. Shear strength of saturated and unsaturated soils (concept only).
Liquefaction and quick sand condition.

MODULE II (Mechanical Modification)

Compaction – principles of soil densifications, compaction control, properties of compacted soil.
Shallow compaction - types of compactors, operational aspects of shallow

compaction.
Dynamic Compaction – Procedure - design considerations,
Vibration methods - Vibro compaction techniques - Blasting, Vibrating compactors, Vibro- floatation, vibro-replacement - stone columns (concept and construction).

MODULE III (Physical and Chemical Modification)

Purpose of physical and chemical additives, Granular admixtures.
Cement - soil-cement-water interactions, effect on engineering properties.
Lime - Soil lime reactions, soil suitability, effect on engineering properties.
Fly ash - effect on soil properties.
Groutability of soil.
Classification of grouting techniques - particulate grouting, Compaction grouting, penetration grouting, jet grouting, displacement grouting – Procedure - soil suitability - merit, and demerit.

MODULE IV (Hydraulic Modification)

Hydraulic modification - Dewatering – Objectives.
Methods of dewatering - open sumps and ditches, Gravity flow wells, Vacuum dewatering, Electro osmosis.
Preloading and vertical drains: preloading with and without vertical drains.

MODULE V (Soil Reinforcement and Use of Geosynthetics)

Soil reinforcement - concept- Reinforcement materials – economy – durability.
Soil nailing & Micro pile - basic concept - construction sequence - areas of application - design considerations - merit and demerit.
Geosynthetics - use, type - function- filtration, drainage, separation - Application of geotextile in different works.
Emerging trends in ground improvement.

Text books

1. Manfred. R. Hausmann, Engineering Principles of Ground Modification, McGraw Hill, 1989
2. P. Purushothama Raj, Ground Improvement Techniques, Laxmi Publications (P) Ltd.

Reference books

1. Jie Han. Principles and Practice of Ground Improvement, John Wiley and Sons, New Jersey, Canada 2015.
2. Donald P. Coduto, Man-chu Ronald Yeung, and William A. Kitch, Geotechnical Engineering: Principles and Practices, Prentice Hall,2000

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (35)
MODULE I (6 hours)		
1.1	Need for ground improvement.	1

1.2	Classification of ground improvement techniques.	1
1.3	Factors affecting the choice of method, objectives of ground improvement, Ground improvement potential.	1
1.4	Excavation and replacement - numerical problems.	1
1.5	Shear strength of soil - frictional strength, cohesive strength.	1
1.6	Shear strength of saturated and unsaturated soils (concept only). Liquefaction and quick sand condition.	1
MODULE II (7 hours)		
2.1	Compaction – principles of soil densifications, compaction control.	1
2.2	Properties of compacted soil.	1
2.3	Shallow compaction - types of compactors.	1
2.4	Operational aspects of shallow compaction.	1
2.5	Dynamic Compaction – Procedure - design considerations.	1
2.6	Vibration methods - Vibro compaction techniques - Blasting, Vibrating compactors.	1
2.7	Vibro-floatation, vibro-replacement - stone columns.	1
MODULE III (7 hours)		
3.1	Purpose of physical and chemical additives, Granular admixtures.	1
3.2	Cement - soil-cement-water interactions, effect on engineering properties.	1
3.3	Lime - Soil lime reactions, soil suitability, effect on engineering properties.	1
3.4	Fly ash - effect on soil properties.	1
3.5	Grouting Techniques - groutability of soil.	1
3.6	Classification of grouting techniques - particulate grouting, Compaction grouting, jet grouting, displacement grouting.	1
3.7	Grouting – Procedure - soil suitability - merit, and demerit.	1
MODULE IV (5 hours)		
4.1	Hydraulic modification - Dewatering - Objectives.	1

4.2	Methods of dewatering - open sumps and ditches, Gravity flow wells.	1
4.3	Methods of dewatering - Vacuum dewatering, Electro osmosis.	1
4.4	Preloading and vertical drains: preloading without vertical drains.	1
4.5	Preloading and vertical drains: preloading with vertical drains.	1
MODULE V (10 hours)		
5.1	Soil reinforcement – concept - Reinforcement materials - economy - durability.	1
5.2	Soil nailing & Micro pile - basic concept.	1
5.3	Areas of application - design considerations - merit and demerit.	1
5.4	Geosynthetics - use, type – function - filtration, drainage, separation.	1
5.5	Application of geotextile in different works.	1
5.6	Emerging trends in ground improvement: Student presentation.	1
5.7	Emerging trends in ground improvement: Student presentation.	1
5.8	Emerging trends in ground improvement: Student presentation.	1
5.9	Emerging trends in ground improvement: Student presentation.	1
5.10	Emerging trends in ground improvement: Student presentation.	1

CO Assessment Questions	
CO1	Suggest a ground improvement technique that can be recommended for strength improvement of a) cohesive soil b) granular soil? Enumerate the reasons.
CO2	Differentiate between vacuum dewatering and electro osmosis.
CO3	Explain the installation procedure of PVD.
CO4	Illustrate the application of geo-textile in (a) Filtration (b) Drainage (c) Erosion control.
CO5	Critically analyze and present any one emerging ground improvement techniques, systematically evaluating their effectiveness, limitations, and potential applications in diverse geotechnical contexts.

24CEE861	GEOENVIRONMENTAL ENGINEERING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of the course is to introduce the geo-environmental aspects related to the soil-water-contaminant interactions, waste disposal facilities, and cleanup of contaminated sites. This course is a blend of geotechnical engineering and environmental concepts and introduces soil behavior, contaminant transport mechanisms, design considerations for leachate and gas collection and management systems, and soil remediation techniques. After the completion of the course, the student will develop knowledge regarding the landfill site characterization, various landfill types and design specifications, and selection of a suitable technique for contaminated site remediation.

Prerequisite: 24CET402 Soil Mechanics

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

CO1	Describe the geo-environmental considerations of waste containment. (Understand Level)
CO2	Explain the contaminant transport mechanisms. (Understand Level)
CO3	Describe the various landfill components and construction of liner systems. (Understand Level)
CO4	Describe the systems of leachate, gas collection, and management. (Understand Level)
CO5	Choose a suitable remediation method for the contaminated site. (Apply Level)

CO – PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply		✓	✓	✓
Analyze				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hrs

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question, 2 questions from each module, each carries 3 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (8×5 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Soil Behavior and Characterization)

Scope of geo-environmental engineering — Multiphase behavior of soil — Role of soil in geo-environmental applications — Importance of soil physics, soil chemistry, hydrogeology, biological process — Impact of ground contamination on geo-environment. Regulatory requirement — Solid waste management rules (brief introduction only), MoEF guidelines. Waste Characteristics of Municipal Solid Waste — Physical, Chemical & Geotechnical.

MODULE II (Contaminant Transport Mechanisms)
Soil mineralogy characterization and its significance in determining soil behavior, Soil-water interaction, and concepts of double layer. Soil-water-contaminant interaction — Mechanisms. Contaminant transport — Advection, Diffusion, Dispersion, Advection - Dispersion equation. Geochemistry — Geochemical Attenuation — Quantification of attenuation capacities — Laboratory evaluation — sequential batch – contact testing & Column percolation testing.
MODULE III (Landfill Types and Components)
Evolution of waste containment facilities and disposal practices — Landfill - Types. Landfill — Site selection — Parameters controlling the selection of site for sanitary and industrial landfill, Site characterization. Components of landfill and its functions, Landfill layout and capacity (Simple numerical problems). Types and functions of liner, compacted clay liner, selection of soil for liner, methodology of construction, geosynthetics clay liners — methodology of construction, testing and design aspects.
MODULE IV (Leachate and Gas Management)
Primary and secondary leachate collection and removal systems — Various components and design considerations, Leachate Management. Cover system — Basic concept and components. Gas extraction systems — passive and active systems, Gas Management. Closure and post-closure monitoring system (brief introduction). Stability of landfill (brief introduction).
MODULE V (Contaminated Site Characterization & Remediation Techniques)
Contaminated Site characterization — risk assessment of contaminated site — Advanced soil characterization (Brief introduction). Remediation methods for soil and groundwater — selection and planning of remediation methods — in-situ / exit remediation, bio remediation, thermal remediation, pump and treat method, phytoremediation and electro-kinetic remediation.
Text books 1. Hari D. Sharma, Krishna R. Reddy (2004) Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Publisher: John Wiley & Sons Inc. 2. Manoj Datta (1997) Waste Disposal in Engineering landfills, Narosa Publishing House, New Delhi.

Reference book

1. Daniel, D. E. (1993) Geotechnical Practice for Waste Disposal. Chapman, and Hall, London.
2. Koerner, R. M. (2005) Designing with Geosynthetics. Fifth Edition. Prentice Hall, New Jersey.
3. Reddi L. N. and Inyang H. I. (2000) Geoenvironmental Engineering: Principles and Applications, Marcel Dekker Inc. Publication.
4. Yong R. N. (2000) Geoenvironmental Engineering: Contaminated Soils, Pollutant Fate, Mitigation Lewis Publication.
5. Dr. G V Rao and Dr. R S Sasidhar (2009) Solid waste Management and Engineered Landfills, Saimaster Geoenvironmental Services Pvt. Ltd. Publication.
6. Ayyar T. S. R. (2000) Soil engineering in relation to environment, LBS centre for Science and Technology, Trivandrum.
7. Donald L. Wise, Debra J. Trantolo, Hilary I. Inyang, Edward J. Cichon (2000) Remediation Engineering of Contaminated Soils, Publisher: Marcel Dekker Inc.
8. Amalendu Bagchi (2004) Design of landfills and integrated solid waste management, John Wiley & Sons. Inc.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (7 Hours)	
1.1	Scope of geo-environmental engineering - Multiphase behavior of soil.	1
1.2	Role of soil in geo-environmental applications – Importance of soil physics, soil chemistry, hydrogeology, biological process.	1
1.3	Impact of ground contamination on geo-environment.	1
1.4	Regulatory requirement -Solid waste management rules (brief introduction only) - MoEF guidelines.	1
1.5	Waste Characteristics of Municipal Solid Waste - Physical.	1
1.6	Waste Characteristics of Municipal Solid Waste - Chemical.	1
1.7	Waste Characteristics of Municipal Solid Waste - Geotechnical.	1

MODULE II (7 Hours)		
2.1	Soil mineralogy characterization and its significance in determining soil behavior.	1
2.2	Soil-water interaction and concepts of double layer.	1
2.3	Soil-water-contaminant interaction - Mechanisms.	1
2.4	Contaminant transport - Transport process - Advection, Diffusion.	1
2.5	Dispersion – Advection - Dispersion equation.	1
2.6	Geochemistry - Geochemical Attenuation - Quantification of attenuation capacities - Laboratory evaluation, sequential batch - contact testing.	1
2.7	Column percolation testing.	1
MODULE III (7 Hours)		
3.1	Evolution of waste containment facilities and disposal practices – Landfill - Types.	1
3.2	Landfill - Site selection- Parameters controlling the selection of site for sanitary and industrial landfills.	1
3.3	Site characterization.	1
3.4	Components of landfill and its functions, Landfill layout and capacity (Simple numerical problems).	1
3.5	Types and functions of liner, compacted clay liner - selection of soil for liner.	1
3.6	Methodology of construction, geosynthetics clay liners - methodology of construction.	1
3.7	Testing and design aspects.	1
MODULE IV (7 Hours)		
4.1	Primary and secondary leachate collection and removal systems - Various components and design considerations.	1
4.2	Leachate Management.	1
4.3	Cover system - Basic concept and components.	1

4.4	Gas extraction systems - passive and active systems.	1
4.5	Gas Management.	1
4.6	Closure and post-closure monitoring system (brief introduction).	1
4.7	Stability of landfill (brief introduction).	1
MODULE V (8 Hours)		
5.1	Contaminated Site characterization.	1
5.2	Risk assessment of contaminated sites.	1
5.3	Advanced soil characterization (Brief introduction).	1
5.4	Remediation methods for soil and groundwater – selection and planning of remediation methods – in-situ / exit remediation.	1
5.5	Thermal remediation.	1
5.6	Bioremediation, Phytoremediation.	1
5.7	Pump and treat method,	1
5.8	Electro-kinetic remediation.	1

CO Assessment Questions	
CO1	Explain the physical and chemical characterization of geotechnical waste.
CO2	Describe the process of advection and dispersion.
CO3	Mention the different factors to be considered for the construction of a compacted clay liner.
CO4	Differentiate between active and passive gas extraction techniques.
CO5	The levels of 17 organochlorine pesticides residues (OCPs) in surface water and sediments from Tamiraparani river basin, South India were investigated to evaluate their potential pollution and risk impacts. A total of 96 surface water and sediment samples at 12 sampling stations were collected along the river in four seasons during 2008–2009. A notable contamination of water and sediment samples was observed upstream (58 ng l^{-1}) and downstream (1,693 ng g^{-1}) that explained the agricultural and municipal outfalls, whereas frequent damming effects reduced the concentration level in the midstream. Recommend and explain a suitable technique for the remediation of the contaminated water and sediments.

24CEE871	HYDROCLIMATOLOGY	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The general objective of this course is to expose the students to the advanced concepts of hydrology and hydrologic systems. The course aims to impart knowledge on the availability of water on the hydrosphere, scientific methods quantifying the components of hydrologic cycle, statistical analysis of hydrologic datasets etc.

Prerequisite: 24CET501 Hydrology and Water Resources Engineering

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

CO1	Explain the role of meteorological variables on the climate of a region. (Understand Level)
CO2	Describe the mechanisms behind regional climate. (Understand Level)
CO3	Apply statistical methods for hydrologic design and modeling of hydro-climatic extremes. (Apply Level)
CO4	Describe the process of modeling the hydrologic impact of climate change. (Understand Level)
CO5	Explain the relevant statistical principles for the characterization of hydrologic data. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	3	-	-	2	-	-	-	-	-
CO4	3	2	-	-	-	-	2	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test 1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours
End Semester Examination [ESE]: Pattern			
PATTERN	**PART A**	**PART B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Hydrometeorology)

Introduction to hydroclimatology: climate system; weather and climate; climate variables affecting precipitation, precipitation and weather, humidity, vapor pressure, saturation vapor pressure–temperature relation, precipitable water, cloud - types; atmospheric stability. Monsoon - wind pattern in India; Indian summer monsoon rainfall-characteristics, role of global climate oscillations on Indian monsoon rainfall; ElNino and LaNina. Extreme precipitation indices.

MODULE II (Hydrometeorology)

Atmosphere - vertical structure; radiation and temperature; the general circulation of atmosphere - triple cell model, global wind circulation; laws of radiation; heat balance of earth atmosphere system; random temperature variation; modeling vertical variation in air temperature; temporal variation of air temperature; thermal time and its computation, heat waves - definition.

MODULE III (Hydroclimatic Extremes)
Climate variability and extremes: Floods - causes, types, methods of control, flood modeling (brief description only), Frequency analysis of extreme rainfall and flood-problems, Return period Risk and reliability in hydrologic design - simple problems. Droughts - types, drought characteristics, drought indices.
MODULE IV (Climate Change Modeling)
Climate change: Causes of climate change, modeling of climate hydrologic impact of climate change - typical framework, general circulation models, regional climate models, Downscaling - statistical and dynamic; IPCC scenarios, CMIP5 and CMIP6 and NCEP databases (brief description and salient features only), Uncertainty in downscaling studies (description only).
MODULE V (Statistical Hydroclimatology)
Statistical methods in hydroclimatology: principal component analysis, statistical significance and determination of confidence interval - methods, methods for change point analysis, trend analysis, randomness, stationary and non-stationary series - determination of non-stationarity of hydro-climatic series (no problems).
Text books 1. G. S. Campbell, and J. M. Norman, An Introduction to Environmental Biophysics, Springer, 2013. 2. Rajib Maity, Statistical Methods in Hydrology and Hydroclimatology, Springer, 2018 3. P. Jayarami Reddy, A Text Book of Stochastic Hydrology, Laxmi Publications, New Delhi, 2nd edition, 2016. 4. M. L. Shelton, Hydroclimatology: Perspectives and Applications, Cambridge University Press, 2009.
Reference books 1. IPCC, Fourth to Sixth Assessment Reports, 2016. 2. M. Karamouz, S Nasif and M Falahi. Hydrology and Hydroclimatology. CRC press, 2012 3. NT. Kottegoda, R Rosso. Applied Statistics for Civil and Environmental Engineers. Wiley Blackwell, 1997 4. KS. Raju, DN Kumar. Impact of Climate change on water resources –with modeling techniques and case studies. Springer, 2008

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (8 hours)	
1.1	Introduction-weather and climate, climate system.	1
1.2	Climate variables - affecting precipitation- climate variables affecting precipitation, humidity, vapor pressure, saturation vapor pressure–temperature relation.	1

1.3	Problems on Hydrometeorology.	1
1.4	Mechanism behind precipitation - precipitable water.	1
1.5	Cloud – types, atmospheric stability.	1
1.6	Monsoon- wind pattern in India, Indian summer monsoon rainfall- characteristics.	1
1.7	Role of global climate oscillations on Indian monsoon rainfall- ElNino and LaNina.	1
1.8	Extreme precipitation indices.	1
MODULE II (7 hours)		
2.1	Atmosphere- vertical structure.	1
2.2	Radiation and temperature; laws of radiation; heat balance of earth atmosphere system.	1
2.3	The general circulation, global wind circulation.	1
2.4	Random temperature variation; modeling vertical variation in air temperature.	1
2.5	Modeling vertical variation in air temperature; temporal variation of air temperature.	1
2.6	Thermal time and its computation; temperature extremes, heat waves- definition.	1
2.7	Case studies on extreme weather.	1
MODULE III (7 hours)		
3.1	Floods- causes, types.	1
3.2	Floods- methods of control, flood modeling.	1
3.3	Frequency analysis of hydro climatic extremes.	1
3.4	Numerical examples from frequency analysis –Gumbel's method.	1
3.5	Return period Risk and reliability in hydrologic design.	1
3.6	Simple problems on hydrologic design.	1
3.7	Droughts-types, drought characteristics, drought indices.	1
MODULE IV (7 hours)		

4.1	Causes of climate change.	1
4.2	Modeling of climate hydrologic impact of climate change-typical framework.	1
4.3	General circulation models, regional climate models.	1
4.4	Downscaling- statistical and dynamic.	1
4.5	IPCC scenarios, CMIP5 and CMIP6 and NCEP databases (brief description and salient features only).	1
4.6	Uncertainty in downscaling studies (description only).	1
4.7	Case studies on climate change impact assessment.	1
MODULE V (7 hours)		
5.1	Principal component analysis.	1
5.2	Statistical significance and determination of confidence interval-methods.	1
5.3	Methods for change point analysis.	1
5.4	Methods for trend analysis.	1
5.5	Methods for determination of randomness.	1
5.6	Stationary and non-stationary series- determination of non-stationarity of hydro-climatic series.	1
5.7	Case studies on climate change impact assessment.	1

CO Assessment Questions	
CO1	1. Differentiate weather and climate. 2. Explain the role of global climate oscillations on Indian monsoon rainfall. 3. Explain the different types of clouds. 4. Differentiate El Nino and La Nina.
CO2	1. Describe the triple cell general circulation model with the help of neat diagrams. 2. Explain thermal time and its computation.
CO3	1. A cofferdam has been built to protect homes in a floodplain until a major channel project can be completed. The cofferdam was built for a 20-year flood event. The channel project will require 3 years to complete. What

	are the probabilities that a) The cofferdam will not be overtopped during the 3 years? b) The cofferdam will be overtopped in any one year? c) The cofferdam will be overtopped exactly once in 3 years? d) The cofferdam will be overtopped at least once in 3 years? e) The cofferdam will be overtopped only in the third year? 2. Explain Return period Risk and reliability in hydrologic design.
CO4	1. Explain general circulation models and regional climate models. 2. Describe the features of CMIP6 climate database.
CO5	1. Explain any three Methods for trend analysis of hydro-climatic data. 2. Describe non-stationarity of hydro-climatic data.

24CEE881	IRRIGATION AND DRAINAGE ENGINEERING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to equip students with the knowledge and skills necessary to estimate crop water requirements, comprehend various methods of water distribution, and understand surface as well as subsurface drainage systems. The goal is to enable students to apply steady and unsteady flow equations while describing drainage systems and their correlation with crop water needs and leaching processes. By the course's conclusion, students will proficiently explain and identify drainage systems according to the crop water requirements, facilitating efficient water management practices in agricultural settings.

Prerequisite: 24CEP403 Fluid Mechanics, 24CET501 Hydrology and Water Resources Engineering

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

CO1	Estimate crop water requirement. (Understand level)
CO2	Identify the different methods of water distribution. (Understand level)
CO3	Describe the surface and subsurface drainage systems. (Understand level)
CO4	Explain steady and unsteady flow equations. (Understand level)
CO5	Identify the drainage system based on crop water and leaching. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	CIA (Marks)	ESE (Marks)	ESE Duration
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Surface Irrigation Methods)

Surface Irrigation methods: Classification – Border irrigation: design parameters, evaluation and ideal wetting pattern – Furrow irrigation: design parameters, types of furrows, evaluation, ideal wetting pattern – Basin irrigation: types of basins, ideal wetting pattern, shapes and size – Efficiency of surface irrigation methods. Crop Water Requirements: Infiltration and movement of water in soil – Soil-water-plant relationship – Water requirement of crops – Evapo transpiration (ET) and consumptive use - Effective rainfall – Irrigation requirement, Soil water balance.

MODULE II (Water Distribution and System Performance)

Irrigation Water Distribution: Canal network and canal regulation – Methods of distribution: supply based and demand based – Delivery of water to farms – Measurement of water – Scheduling of irrigation – Criteria for scheduling, constraints – Frequency and interval of irrigation. Irrigation System Performance Indicators: Systems

classification – Rehabilitation and modernization – Performance indicators – Improving system performance – constraints.

MODULE III (Land Drainage Systems)

Land Drainage systems: necessity – types - surfaces and subsurface drainage - design considerations. Soil Water Zone: Description, Flow through soil water zone - Physical properties of soil - hydraulic conductivity - saturated thickness - drainable pore space - storativity, hydraulic resistance, leakage factor - Ground water data - concepts of groundwater hydrograph, groundwater maps, Isobath map, water table fluctuation maps etc. Drainage studies - continuity equation, Laplace equation, relaxation method of solution - Typical boundary conditions like impervious layer, plane of symmetry, freewater surface, water at rest or slowly moving water, seepage surface.

MODULE IV (Analysis of Open Drain Flow)

Flow into open drains - steady state equations - Hooghoudt equation, Principles, applications for design use of nomographs for homogeneous and layered soils – Earnst equation, concept of horizontal vertical and radial flow, application to layered soils. Unsteady state drainage equations - Glover Dum equation, application, concept of Kraijenhoff Vande Leur Mass land equation, application - analysis for constant recharge, intermittent recharge cases.

MODULE V (Planning of Open Drainage Systems)

Layout of open drainage systems: types - Field drains, design considerations of ditch drains - Mole drains, design considerations, suitability - Sub-surface drainage systems - Pipe drainage systems - design for uniform and non-uniform flow conditions - transport and dewatering situations. Patterns of drainage system - Drainage criteria formulation for off-season drainage, crop season drainage, salt drainage - use of steady state and unsteady state approaches in formulation - criteria for irrigated area – incorporation of intentional and unavoidable losses. Salinity and drainage - cause of salinity, salt balance equation, leaching efficiency, salt equilibrium equation and leaching requirement.

Text books

1. Majumdar D P, Irrigation Water Management Principles and Practices, Prentice Hall of India, New Delhi, 2000.
2. Michel A M, Irrigation Theory and Practice, Vikas Publishing House, New Delhi, 2008.
3. Bhattacharya A K and Michael A M, Land Drainage Principles: Methods and Applications, Konark Publishers Pvt. Ltd., New Delhi, 2003.

Reference books

1. James J G, Principles of Farm Irrigation system Design, John Wiley & Sons, New York, 1988.
2. Sharma S K, Principles and Practice of Irrigation Engineering, S. Chand & Company Pvt. Ltd, New Delhi.
3. Punmia B C, and B B Pande, Irrigation and Water Power Engineering, Laxmi Publication Pvt. Ltd., New Delhi.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (36)
MODULE I (7 hours)		
1.1	Surface Irrigation methods: Classification – balance.	1
1.2	Border irrigation: design parameters, evaluation and ideal wetting pattern.	1
1.3	Furrow irrigation: design parameters, types of furrows, evaluation, ideal wetting pattern.	1
1.4	Basin irrigation: types of basins, ideal wetting pattern, shapes and size.	1
1.5	Efficiency of surface irrigation methods. Crop Water Requirements: Infiltration and movement of water in soil.	1
1.6	Soil-water-plant relationship – Water requirement of crops.	1
1.7	Evapo transpiration (ET) and consumptive use - Effective rainfall – Irrigation requirement, Soil water.	1
MODULE II (7 hours)		
2.1	Irrigation Water Distribution: Canal network and canal regulation.	1
2.2	Methods of distribution: supply based and demand based.	1
2.3	Delivery of water to farms – Measurement of water – Scheduling of irrigation.	1
2.4	Criteria for scheduling, constraints – Frequency and interval of irrigation.	1
2.5	Irrigation System Performance Indicators: Systems classification.	1
2.6	Rehabilitation and modernization – Performance indicators.	1
2.7	Improving system performance – constraints.	1
MODULE III (7 hours)		
3.1	Land Drainage systems: necessity – types - surfaces and subsurface drainage - design considerations.	1
3.2	Soil Water Zone: Description, Flow through soil water zone.	1
3.3	Physical properties of soil - hydraulic conductivity - saturated thickness - drainable pore space - storativity, hydraulic resistance, leakage factor.	1
3.4	Ground water data - concepts of ground water hydrograph,	1

	ground water maps, Isobath map, water table fluctuation maps etc.	
3.5	Drainage studies - continuity equation.	1
3.6	Laplace equation, relaxation method of solution.	1
3.7	Typical boundary conditions like impervious layer, plane of symmetry, freewater surface, water at rest or slowly moving water, seepage surface.	1
MODULE IV (7 hours)		
4.1	Flow into open drains - steady state equations.	1
4.2	Hooghoudt equation, Principles, applications for design use of nomographs for homogeneous and layered soils.	1
4.3	Earnst equation, concept of horizontal vertical and radial flow.	1
4.4	Application to layered soils.	
4.5	Unsteady state drainage equations - Glover Dum equation, application.	1
4.6	concept of Kraijenhoff Vande Leur Mass land equation.	1
4.7	Application - analysis for constant recharge, intermittent recharge cases.	1
MODULE V (8 hours)		
5.1	Layout of open drainage systems: types - Field drains, design considerations of ditch drains.	1
5.2	Mole drains, design considerations, suitability - Sub-surface drainage systems.	1
5.3	Pipe drainage systems - design for uniform and non-uniform flow conditions.	1
5.4	Transport and dewatering situations. Patterns of drainage system.	1
5.5	Drainage criteria formulation for off season drainage, crop season drainage, salt drainage.	1
5.6	use of steady state and unsteady state approaches in formulation - criteria for irrigated area.	1
5.7	incorporation of intentional and unavoidable losses. Salinity and drainage - cause of salinity, salt balance equation.	1
5.8	leaching efficiency, salt equilibrium equation and leaching requirement.	1

CO Assessment Questions	
CO1	1. Define crop water requirement 2. A rice field in a specific region has an average pan evaporation rate of 7 mm/day during the growing season. Given that the crop coefficient (K_c) for rice at a certain growth stage is 1.2, calculate the daily water requirement for irrigation per hectare of rice field during this stage, assuming no precipitation during this period.
CO2	1. Differentiate between demand based and supply based irrigation methods. 2. Explain scheduling of irrigation.
CO3	1. Explain the types of land drainage system. 2. Define (i) storativity, (ii) hydraulic conductivity, (iii) leakage factor.
CO4	1. Differentiate between Hooghoudt equation and Earnst equation in their principles and applications for designing drainage systems in homogeneous and layered soils? How are nomographs utilized in the context of these equations for soil drainage design? 2. Explain the practical applications and differences between steady state (horizontal, vertical, and radial flow) and unsteady state drainage equations, such as Glover Dum equation and Kraijenhoff Vande Leur Mass land equation? How are these equations applied in scenarios involving constant and intermittent recharge, particularly in analyzing drainage systems?
CO5	1. Explain the causes of salinity and the methods to avoid it. 2. Explain the design conditions for mole drains.

24CEE891	SOLID WASTE MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course in solid waste management provides a comprehensive education in the principles and practices of collecting, handling, disposing of, and recycling various types of solid waste. Students will gain a deep understanding of waste management and design of waste disposal facilities. After the completion of the course, the students will be able to contribute to the development of effective waste management solutions through a blend of theoretical knowledge and practical exposure.

Prerequisite: 24CET503 Environmental Engineering

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

CO1	Discuss the waste generation, characterization and management practices. (Understand and Analyse level)
CO2	Describe the waste collection, sorting and transportation systems. (Understand level)
CO3	Compare the different waste to energy and waste treatment technologies. (Understand level)
CO4	Elaborate the various waste disposal methodologies and design landfills. (Understand and Apply level)
CO5	Explain the CPCB regulations for the management of hazardous waste, biomedical waste, e-waste and construction and demolition waste. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	3	1	-	-	-	-	3
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	2	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	3	1	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓	✓	✓
Apply		✓	✓	✓
Analyse			✓	
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Introduction to Solid Waste Management)

Overview of solid waste management and its significance - Overview of waste management regulations and policies - Role of government agencies and stakeholders in waste management.

Waste Generation and Characterization - Sources and types of solid waste - Waste composition analysis and characterization techniques (overview only).

Solid waste management hierarchy - Waste minimization strategies and techniques - Environmental and social impacts of improper waste management.

MODULE II (Waste Collection and Transportation)

Waste collection systems and equipment - Route optimization and scheduling Transfer stations and their role in waste transportation.

Waste sorting and separation techniques - Challenges and unique considerations

for developing countries - Appropriate technologies for resource-constrained settings.
Recycling and Resource Recovery - Principles of recycling and resource recovery - Recycling technologies and processes.

MODULE III (Waste Treatment)

Basics of composting and its benefits - Composting methods and process control - Large-scale composting and its applications.
Waste-to-energy conversion technologies: incineration, gasification, pyrolysis, anaerobic digestion - Incineration processes and emissions control - Environmental and energy considerations of waste-to-energy systems.

MODULE IV (Waste Disposal)

Disposal methods: Dumping, burial, landfill - Landfill site selection and design considerations - Liner systems and leachate management - Landfill gas collection and utilization – design of landfill.
Integrated Solid Waste Management: Integrated waste management principles and approaches - Policy and planning considerations for integrated waste management - Case studies of successful integrated waste management systems.
Visit to local waste management facilities (e.g., recycling centers, composting sites, landfill): Discussion and reflection on the field trip experience.

MODULE V (Management of Special Wastes)

Hazardous waste management: Identification and classification of hazardous waste, Storage, handling, and disposal of hazardous waste, CPCB regulations
Construction and Demolition Waste Management: overview, CPCB Guidelines for environmental management of construction and demolition waste.
Biomedical waste management – overview and regulations.
E-waste Management: Overview of electronic waste and its environmental impacts – CPCB regulations.

Text books

1. Bhatia, S. C., Solid and Hazardous Waste Management. Atlantic Publishers and Distributors, New Delhi, 2007.
2. John Pitchel, Waste Management Practices -Municipal, Hazardous, and Industrial, Second Edition, CRC Press - Boca Raton, 2014.
3. CPHEEO, Ministry of Urban Development, Government of India, Manual on Municipal Solid Waste Management, New Delhi, 2000.
4. Central Pollution Control Board, GoI, Guidelines for Management of Healthcare Waste as per Biomedical Waste Management Rules, 2016.
5. Central Pollution Control Board, GoI, Guidelines on environmental management of construction & demolition (c & d) wastes, 2017.
6. Government of India Ministry of Environment, Forest and Climate Change, Hazardous and other Wastes (Management and Transboundary Movement) Rules, 2016 and subsequent amendments.

Reference books

1. George Tchobanoglous and Frank Kreith, Handbook of solid waste

management, McGraw Hill publications –New York, 2002.
2. Bhide A.D. and Sundaresan, B.B, Solid Waste Management Collection, Processing and Disposal, 2001.
3. M. N. Rao, Razia Sultana, Solid and Hazardous Waste Management, Second Edition BS Publications, 2020.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
MODULE I (7 hours)		
1.1	Overview of solid waste management and its significance.	1
1.2	Overview of waste management regulations and policies.	1
1.3	Role of government agencies and stakeholders in waste management.	1
1.4	Waste Generation and Characterization - Sources and types of solid waste.	1
1.5	Waste composition analysis and characterization techniques (overview only).	1
1.6	Solid waste management hierarchy - Waste minimization strategies and techniques.	1
1.7	Environmental and social impacts of improper waste management.	1
MODULE II (8 hours)		
2.1	Waste collection systems and equipment.	1
2.2	Route optimization and scheduling.	1
2.3	Transfer stations and their role in waste transportation.	1
2.4	Waste sorting and separation techniques.	1
2.5	Challenges and unique considerations for developing countries.	1
2.6	Appropriate technologies for resource-constrained settings.	1
2.7	Recycling and Resource Recovery - Principles of recycling and resource recovery.	1
2.8	Recycling technologies and processes.	1
MODULE III (6 hours)		

3.1	Basics of composting and its benefits - Composting methods and process control.	1
3.2	Composting methods and process control - Large-scale composting and its applications.	1
3.3	Waste-to-energy conversion technologies: incineration, gasification.	1
3.4	Waste-to-energy conversion technologies: pyrolysis, anaerobic digestion.	1
3.5	Incineration processes and emissions control.	1
3.6	Environmental and energy considerations of waste-to-energy systems.	1
MODULE IV (7 hours)		
4.1	Disposal methods: Dumping, burial, land fill.	1
4.2	Landfill site selection and design considerations.	1
4.3	Liner systems and leachate management - Landfill gas collection and utilization.	1
4.4	Design of landfill.	1
4.5	Integrated waste management principles and approaches - Policy and planning considerations for integrated waste management.	1
4.6	Case studies of successful integrated waste management systems.	1
4.7	Discussion and reflection on the field trip experience.	1
MODULE V (8 hours)		
5.1	Identification and classification of hazardous waste.	1
5.2	Storage, handling, and disposal of hazardous waste.	1
5.3	Hazardous waste - CPCB regulations.	1
5.4	Construction and Demolition Waste Management: overview.	1
5.5	Construction and Demolition Waste - CPCB Guidelines.	1
5.6	Biomedical waste management – overview and regulations.	1
5.7	Overview of electronic waste and its environmental impacts.	1

5.8	Electronic waste - CPCB regulations.	1

CO Assessment Questions	
CO 1	1. Classify solid waste according to sources. 2. Conduct a door-to-door survey and analyse the characteristics of solid waste according to source.
CO 2	Enlist and explain the equipment required for waste collection.
CO 3	Describe Bangalore method of composting with a neat sketch.
CO 4	1. Explain with a neat sketch the various components of a sanitary landfill and its functions. 2. Design the thickness of the clay liner of a landfill, if the breakthrough time for leachate to penetrate the liner is 20 years. Assume coefficient of permeability as 5 x 10^{-8}cm/s and effective porosity as 0.17. hydraulic head is 30 cm greater than the thickness of the liner.
CO 5	Discuss the CPCB regulations for biomedical waste management.

24CEE8101	AIR QUALITY MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of the course is to provide engineering knowledge on air pollution, air quality monitoring and air pollution control strategies among students. This course includes health effects of air pollutants, dispersion of pollutants in the atmosphere, monitoring and control strategies for air pollutants. The students will be able to take appropriate actions to reduce the impact of air pollution for the benefit of the society.

Prerequisite: Nil

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

CO 1	Explain the sources of air pollution and different types of air pollutants. (Understand level)
CO 2	Describe the effect of air pollutants on vegetation, animals, materials and human health. (Understand level)
CO 3	Explain the meteorological aspects of air pollutant dispersion. (Understand level)
CO 4	Discuss the different methods of ambient air quality monitoring system which supports an air quality management programme. (Understand level)
CO 5	Describe the various air pollution control strategies that can be undertaken to meet the air quality goals. (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	-	2	2	-	-	-	-	-
CO 2	3	-	-	-	-	2	1	-	-	-	-	-
CO 3	3	-	-	-	-	2	2	-	-	-	-	-
CO 4	3	-	-	-	-	3	2	-	-	-	-	-
CO 5	3	-	-	-	-	2	2	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3hrs

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Air Pollution: Sources and Types)

Introduction - Components of Environment - Definition – Air Pollution - History of air pollution episodes - Sources of Air pollution – Industrial Processes causing Air Pollution - Air Pollutants - Types of Air Pollutants - Criteria Pollutants. Behaviour and fate of air pollutants.

MODULE II (Effects of Air Pollution)

Effect of air pollutants on health, vegetation, animals and materials and environment - Greenhouse effect - Indoor Air Pollution - Sources of indoor air pollutants - Effects of indoor air pollution.

MODULE III (Meteorological Aspects of Air Pollutant Dispersion)

Meteorological aspects of Air Pollutant Dispersion - Temperature and Pressure relationships - Atmospheric Stability - Temperature Lapse Rate – Inversions - Types, Plume behaviour. Dispersion of Air pollutants - Plume dispersion theory - Gaussian

plume model (Derivation not required) – Assumptions - Advantages and Disadvantages - Pasquill's stability curves.

MODULE IV (Air Pollution Sampling and Measurement)

Air Quality monitoring - Ambient air sampling - Collection of gaseous air pollutants - Collection of particulate Pollutants - Instrumentation and methods of analysis of SO2 and CO - Ambient Air Quality standards - Emission Inventory.

MODULE V (Air Pollution Control Methods)

Control of Air Pollutants - Particulate emission control - methods, Scrubbing – Cyclones – Filtration - Electrostatic Precipitation - Gaseous emission control - adsorption, absorption, thermal methods. Legislation for control of air pollution and automobile pollution.

Text books

1. C. S. Rao, "Environmental Pollution Control Engineering", New Age International Pub., 2006.
2. M. N. Rao & H. V. N Rao, Air Pollution, Tata McGraw Hill Co. Ltd, Delhi, 1990.
3. Peavy H S, Rowe, D.R. Tchobanaglous "Environmental Engineering" McGraw Hill Education, 1985.

Reference books

1. Beat Meyer, Indoor Air Quality, Addison – Wesley Publishers.
2. Chhatwal G. R., Encyclopedia of Environmental Pollution and Control, Vol.1, 2 & 3, Anmol Publications.
3. Noel de Nevers, Air Pollution Control Engineering, McGraw Hill, New York, 1995.
4. Stern A, "Air Pollution" (Volume I, II & III), Academic Press New York, 1962.
5. SC Bhatia, Textbook of Air Pollution and Its Control, Atlantic publishers, 2007.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36hrs)
	MODULE I (7 hours)	
1.1	Introduction - Components of Environment.	1
1.2	Definition – Air Pollution - History of air pollution episodes.	1
1.3	Sources of Air pollution.	1
1.4	Industrial Processes causing Air Pollution.	1
1.5	Air Pollutants - Types of Air Pollutants.	1
1.6	Criteria Pollutants.	1

1.7	Behaviour and fate of air pollutants.	1
MODULE II (7 hours)		
2.1	Effect of air pollutants on health.	1
2.2	Effect of air pollutants on vegetation.	1
2.3	Effect of air pollutants on animals.	1
2.4	Effect of air pollutants on materials and environment.	1
2.5	Greenhouse effect.	1
2.6	Indoor Air Pollution - Sources of indoor air pollutants.	1
2.7	Effects of indoor air pollution.	1
MODULE III (8 hours)		
3.1	Meteorological aspects of Air Pollutant Dispersion - Temperature and Pressure relationships.	1
3.2	Atmospheric Stability - Temperature Lapse Rate.	1
3.3	Inversions – Types.	1
3.4	Plume behaviour.	1
3.5	Dispersion of Air pollutants - Plume dispersion theory.	1
3.6	Gaussian plume model Assumptions.	1
3.7	Advantages and Disadvantages of Gaussian plume model.	1
3.8	Pasquill's stability curves.	1
MODULE IV (6 hours)		
4.1	Air Quality monitoring - Ambient air sampling.	1
4.2	Collection of gaseous air pollutants.	1
4.3	Collection of particulate Pollutants.	1
4.4	Instrumentation and methods of analysis of SO2 and CO.	1

4.5	Ambient Air Quality standards.	1
4.6	Emission Inventory.	1
MODULE V (8 hours)		
5.1	Control of Air Pollutants - Particulate emission control-methods, Scrubbing.	1
5.2	Particulate emission control-methods – Cyclones.	1
5.3	Particulate emission control-methods – Filtration.	1
5.4	Particulate emission control-methods - Electrostatic Precipitation.	1
5.5	Gaseous emission control - adsorption, absorption.	1
5.6	Gaseous emission control - thermal methods.	1
5.7	Legislation for control of air pollution.	1
5.8	Legislation for control of automobile pollution.	1

CO Assessment Questions	
CO1	Explain major air pollution episodes.
CO2	Discuss the effects of air pollutants on human health.
CO3	Explain the effect of meteorological factors on dispersion of air pollutant.
CO4	Explain various methods used for the sampling of particulate air pollutants.
CO5	Explain the working of an Electrostatic precipitator for particulate emission control.

24CEE8111	HIGHWAY MATERIALS AND DESIGN	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The aim of this course is to enhance the knowledge and understanding of students regarding the desirable properties of various pavement construction materials and different pavement design techniques. This covers the specifications recommended by various codes and procedures for design in different countries and throughout history. This course will enable students to design different types of roads after thoroughly evaluating the material properties and applying the various pavement theories.

Prerequisite: 24CET402 Soil Mechanics

Course Outcomes:

	After the completion of the course, the student will be able to
CO1	Identify the desirable attributes of aggregates to be used in various pavement constructions along with their determination and specifications. (Understand Level)
CO2	Identify the desirable properties of bitumen influencing its grading and suitability to be used in various flexible pavements along with its determination and specifications. (Understand Level)
CO3	Identify the desirable attributes of soil influencing its suitability to be used as a subgrade layer along with its determination and specifications. (Understand Level)
CO4	Explain the design procedure of flexible and rigid pavement and various theories developed throughout history. (Understand Level)
CO5	Explain the stresses developed in different types of pavement along with theories for its determination. (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	1	1	-	-	-	-	-	-	-	-	-	-
CO 2	1	1	-	-	-	-	-	-	-	-	-	-
CO 3	2	3	-	-	-	-	-	-	-	-	-	-
CO 4	-	2	-	-	-	-	-	-	-	-	-	-
CO 5	2	1	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS
Module I (Desirable Properties and Testing of Road Aggregates)
Introduction to highway pavements, Types and component parts of pavements, Factors affecting design and performance of pavements, Pavement Materials - Road aggregates, Tests on aggregates and specifications for flexible and rigid pavements, Principles and methods of Gradation for soil - Aggregate mixes. Alternate Materials for durable pavements - Artificial aggregates.
Module II (Desirable Properties and Testing of Bitumen)
Properties and tests on Bituminous binders - Methods of grading, Emulsions - Properties and tests, Cut backs and Modified binders - Types, characteristics and uses, aging of bitumen and aging tests.

Module III (Testing of Subgrade Soil and Pavement Mixes)
Functions and significance of subgrade properties, Various methods of assessment of sub grade soil strength for pavement design. Testing of sub base, base course and interlayer materials. Mix design procedures in mechanical stabilisation of soils, Design of bituminous mixes by Marshall, Hubbard - field and Hveem's methods.
Module IV (Flexible Pavement Design)
Introduction to analysis and design of flexible pavements, Stresses and deflections in homogeneous masses, Burmister's 2 layer and 3 layer theories, Wheel load stresses, Equivalent Single Wheel Load (ESWL) of multiple wheels, Repeated loads and EWL factors, Empirical, semi-empirical and theoretical approaches for flexible pavement design, Group index, CBR, Triaxial, Mcleod and Burmister layered system methods.
Module V (Rigid Pavement Design)
Introduction to analysis and design of rigid pavements, Types of stresses and causes, Factors influencing stresses, General conditions in rigid pavement analysis, Warping stresses, Frictional stresses, Combined stresses. Joints in cement concrete pavements, Joint spacings, Design of slab thickness, Design and detailing of longitudinal, contraction and expansion joints, IRC methods of Design.
Text Books: 1. Justo C.E.G, Veeraragavan A and Khanna S.K; Highway Engineering, Nem Chand Publishers, Revised 10th Ed, 2018. 2. Yoder E J and Witezak, M W Principles of Pavement Design, John Wiley and sons, 2nd Edition 2011. 3. Kadiyali L R: Highway Engineering, Khanna publication Revised Edition, 2017. **Reference Books:** 1. Yang, H H Design of functional pavements, McGraw-Hill, 1973. 2. Atkins, H.N Highway Materials, Soils, and Concrete, Prentice Hall, 2002. 3. Krebs, R.D. Highway Materials, McGraw Hill Text, 1971. 4. Relevant IRC codes. 5. MORTH specifications.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hour (36)
Module I (5 Hours)		
1.1	Introduction to highway pavements, Types and component parts of pavements.	1
1.2	Factors affecting design and performance of pavements.	1
1.3	Tests on aggregates and specifications for flexible and rigid pavements.	1
1.4	Principles and methods of Gradation for soil - Aggregate mixes.	1
1.5	Alternate Materials for durable pavements - Artificial aggregates.	1

Module II (5 Hours)		
2.1	Properties and tests on Bituminous binders.	1
2.2	Methods of grading - Penetration, Viscosity and Performance.	1
2.3	Emulsions - Properties and tests.	1
2.4	Cut backs and Modified binders - Types, characteristics and uses.	1
2.5	Aging of bitumen and aging tests.	1
Module III (7 Hours)		
3.1	Functions and significance of sub-grade properties.	1
3.2	Various methods of assessment of sub-grade soil strength for pavement design.	1
3.3	Testing of sub-base, base course and interlayer materials.	1
3.4	Mix design procedures in mechanical stabilization of soils.	1
3.5	Design of bituminous mixes by Marshall method.	1
3.6	Design of bituminous mixes by Hubbard – field.	1
3.7	Design of bituminous mixes by Hveem's method.	1
Module IV (11 Hours)		
4.1	Introduction to analysis and design of flexible pavements.	1
4.2	Stresses and deflections in homogeneous masses - Boussinesq's method.	1
4.3	Burmister's 2 layer and its problems.	1
4.4	Burmister's 3 layer and its problems.	1
4.5	Wheel load stresses, ESWL of multiple wheels, Repeated loads and EWL factors.	1
4.6	Introduction to empirical, semi-empirical and theoretical approaches for flexible pavement design.	1
4.7	Group index design of Bituminous pavement and its problems.	1
4.8	CBR method of Bituminous pavement design and its problems.	1
4.9	Triaxial method of Bituminous pavement design and its problems.	1
4.10	Mcleod method of Bituminous pavement design and its problems.	1
4.11	Burmister layered system method of Bituminous pavement design and its problems.	1

Module V (8 Hours)		
5.1	Introduction to analysis and design of rigid pavements.	1
5.2	Types of stresses and causes in Rigid pavement, Factors influencing stresses.	1
5.3	General conditions in rigid pavement analysis, Warping stresses, Frictional stresses, Combined stresses.	1
5.4	Problems on stress computations in Rigid pavement.	1
5.5	Joints in cement concrete pavements, Joint spacing.	1
5.6	Design of slab thickness.	1
5.7	Design and detailing of longitudinal, contraction and expansion joints.	1
5.8	IRC methods of Rigid pavement design.	1

CO Assessment Questions	
CO 1	Explain the desirable properties of aggregates to be used in pavement.
CO 2	Explain the grading criteria for paving bitumen.
CO 3	Elaborate the relevant tests to be conducted on subgrade soil.
CO 4	Explain the IRC method of flexible pavement design.
CO 5	Discuss the position and relevance of various joints provided in the rigid pavement with the help of neat sketches.

24CEE8121	MULTI MODAL URBAN TRANSPORTATION SYSTEMS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective of this course is to expose the students to the concept of travel demand management and sustainable principles of urban public transit system. It introduces students to the concepts of vehicular Level of Service and how to plan non-motorised transportation system. After this course students will be able to measure the transit system performance for designing transfer facilities within a road network.

Prerequisite: Nil

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

CO1	Discuss urban transportation dynamics, challenges and components of bus transportation operations. (Understand Level)
CO2	Explain standard procedures for the planning of NMT systems. (Understand Level)
CO3	Apply the concepts of vehicular level of service for measuring the performance of a given transit system. (Apply Level)
CO4	Calculate the level of service of bicycle and pedestrian facilities of a given roadway. (Apply Level)
CO5	Calculate the multimodal level of service for the design of multimodal transfer facilities for a given road network. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	1	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember				
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Overview of Urban Transportation)

Urbanization and Transport, Key issues in urban transportation, Challenges in urban transportation, Travel demand modelling and Vehicular Level of Service (LOS) (Overview) Public Transportation: Introduction to public transportation, Basic operating elements of public transportation - Bus Transportation.

MODULE II (Transit Systems and Management)
Financing public transportation, Transit marketing, Rail transportation, Intermediate Public Transportation, Measuring performance of transit systems, Advanced operation concepts of public transportation, Bus & Rail Transit Capacity, Station Capacity, Transit Stop Location.
MODULE III (Pedestrian and NMT System Analysis)
Introduction to Non-Motorised Transportation (NMT) Systems, Assessing existing NMT scenario, Data collection and analysis in NMT Planning, Complementarity and Selection of Interventions, Alternative Selection through Economic & Financial Analysis, Basic NMT Characteristics. Pedestrian Studies - Pedestrian Data Collection and Flow Characteristics, Public transport system Case Study on Pedestrian flow characteristics on facilities, Pedestrian Level of Service (PLOS) based on Flow models .
MODULE IV (Sustainable Mobility Systems and Strategies)
Other types of Pedestrian Level of Service, HCM 2010 Methodology for PLOS, Bicycle Facilities and Level of Service, BLOS and Bicycle Compatibility Index (BCI), Design of Pedestrian Infrastructure, Design of Cycling Infrastructure.
MODULE V (Multimodal Transit and Development)
Travel Demand Management (TDM) (overview), Push measures cases, Pull measure cases, Parking Studies, Transit Oriented Development. (TOD) Multimodal transportation (MMT) environment, Multimodal Level of Service (MMLOS), Design of multimodal transfer facilities, Park & Ride (P&R) Facility Planning.
Text Books 1. Travel Demand Management and Road User Pricing: Success, Failure and Feasibility, edited by Gerd Sammer & Wafaa Saleh (2009), Ashgate. 2. The Implementation and Effectiveness of Transport Demand Management Measures - An International Perspective, edited by Stephen Ison, Tom Rye, (2008), Ashgate. 3. Sustainable Transport: Planning for Walking and Cycling in Urban Environments, edited by Rodney Tolley (2003) Woodhead Publishing Ltd.
Reference books 1. Fundamentals of Intelligent Transportation Systems Planning, by Mashrur A. Chowdhury, Adel Wadid Sadek, (2003) Artech House, Inc. Boston. 2. Fruin, J.J. Pedestrian Planning and Design, McGraw Hill Publication, 1987 5. Hudson, M. The Bicycle Planning, Open Books, 1982. 3. Ceder, A., 2016. Public Transit Planning and Operation: Modeling, Practice and Behavior, 2nd Ed., CRC Press. 4. Traffic & Highway Engineering, Garber, N.J., and Hoel, L.A., 5 th Edition, Cengage Learning, 2015.

5. IRC 103:2012, Design of Pedestrian Facilities. Indian Road Congress.

6. IRC 11: 2015 Design & Layout of Cycle Tracks. Indian Road Congress.

7. Indo-Highway Capacity Manual (HCM), CSIR-CRRI, 2018.

8. TOD Guidance Document. Ministry of Housing and Urban Affairs, GoI.

9. NMT Guidance Document. Ministry of Housing and Urban Affairs, GoI.

10. PBS Guidance Document. Ministry of Housing and Urban Affairs, GoI.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE 1 (7 hours)	
1.1	Overview of urban transportation: Urbanization and Transport.	1
1.2	Key issues in urban transportation, Challenges in urban transportation.	1
1.3	Travel demand modelling and Vehicular Level of Service (LOS). (Overview)	1
1.4	Public Transportation: Introduction to public transportation.	1
1.5	Basic operating elements of public transportation.	1
1.6	Bus Transportation.	1
1.7	Bua Transportation (Contd.).	1
	MODULE 2 (7 hours)	
2.1	Financing public transportation.	1
2.2	Transit marketing, Rail transportation.	1
2.3	Intermediate Public Transportation.	1
2.4	Measuring performance of transit systems.	1
2.5	Advanced operation concepts of public transportation.	1
2.6	Bus & Rail Transit Capacity, Station Capacity.	1
2.7	Transit stop location.	1
	MODULE III (8 hours)	

3.1	Introduction to Nonmotorized Transportation (NMT) Systems, Assessing existing NMT scenario.	1
3.2	Data collection and analysis in NMT Planning.	1
3.3	Complementarity and Selection of Interventions.	1
3.4	Alternative Selection through Economic & Financial Analysis, Basic NMT Characteristics.	1
3.5	Pedestrian Studies - Pedestrian Data Collection and Flow Characteristics.	1
3.6	Public transport system Case Study on Pedestrian flow characteristics on facilities.	1
3.7	Pedestrian Level of Service (PLOS) based on Flow models.	1
3.8	Pedestrian Level of Service (PLOS) based on Flow models (Contd..)	1
MODULE IV (7 Hours)		
4.1	Other types of Pedestrian Level of Service.	1
4.2	HCM 2010 Methodology for PLOS.	1
4.3	HCM 2010 Methodology for PLOS. (Contd..	1
4.4	Bicycle Facilities and Level of Service.	1
4.5	BLOS and Bicycle Compatibility Index. (BCI)	1
4.6	Design of Pedestrian Infrastructure.	1
4.7	Design of Cycling Infrastructure.	1
MODULE V (7 Hours)		
5.1	Travel Demand Management. (TDM)	1
5.2	Push measures cases, Pull measure cases.	1
5.3	Parking Studies.	1
5.4	Transit Oriented Development. (TOD)	1
5.5	Multimodal transportation (MMT) environment, Multimodal Level of Service. (MMLOS)	1
5.6	Design of multimodal transfer facilities.	1
5.7	Park & Ride (P&R) Facility Planning.	1

CO Assessment Questions	
CO1	Discuss about the challenges in urban transportation.
CO2	Discuss the step-by-step approach of NMT planning.

CO3	Hyderabad is examining opportunities to improve transit service through its downtown core. Existing bus service to downtown is concentrated on Street 10 A, a one-way route of 6km in length with 5 bus stops. The route has seven transit routes with combined peak hour frequency of 27 buses per hour. It has three through lanes, with on-street parking provided on both sides of the street. Buses stop every block with average block length of 1.2 Km. On-street parking is removed at bus stops to allow the buses access to the curb, and buses must exit the traffic stream to serve passengers. Traffic signals are located at each intersection down the downtown street. Calculate the average dwell time, loading area capacity and bus stop capacity of a designated roadway, considering factors like number of transit routes, peak hour frequency etc.
CO4	Determine the link PLOS score and the corresponding PLOS of the roadway using the HCM 2010 methodology. Input data is given below. Sidewalk width- 10 feet Outside lane width- 12 feet Bicycle lane width- 0 feet Shoulder/parking lane width- 8 feet Percentage of segment with occupied on street parking- 50% or 0.5 Street trees or other barriers- No Landscape buffer width- 0 Curb presence- Yes No. of travel lanes- 2 Directional vehicle volume- 706 veh./hr Vehicle running speed- 35 mph.
CO5	Determine the TTR, LOS, IR between two origin-destination pairs, whose riders had the following average value of travel time. The commuter undergo multiple access and egress travel in order to use the metro system. Also comment on the performance of public transport system, with respect to the multimodal network. Input data is given below. Access time- 10 minutes Egress time- 14 minutes Transfer time- 1.5 minutes Wait time at transfer point- 5 minutes IVTT- 20 minutes Time taken when journey is done by car- 30 minutes.

OPEN ELECTIVE – 2

24CEO812	REMOTE SENSING AND GIS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course aims to provide comprehensive insights into Remote Sensing, GIS, Database Management, Spatial Data Analysis, and their practical applications. The goal is to equip learners with a deep understanding of these technologies and their real-world applications. Upon completion, students will grasp the foundational principles of remote sensing and GIS, interpret remote sensing data, manage spatial databases efficiently, conduct spatial data analysis.

Prerequisite: Nil

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

CO1	Explain the fundamentals of Remote Sensing. (Understand Level)
CO2	Discuss the concepts of Geographic Information System. (Understand Level)
CO3	Explain different spatial data management systems. (Understand Level)
CO4	Describe the methods of data analysis. (Understand Level)
CO5	Identify the application of Geographic Information System. (Understand Level)

CO – PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	1	-	-	-	-	-	-	-	-	-
CO2	3	-	1	-	-	-	-	-	-	-	-	-
CO3	3	1	1	1	1	-	-	-	-	-	-	-
CO4	3	1	1	1	1	-	-	-	-	-	-	-
CO5	3	1	1	1	1	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply			✓	
Analyse				
Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L-T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub-divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (Introduction to Remote sensing)

Concepts of Remote Sensing - Basics of remote sensing- elements involved in remote sensing,
electromagnetic spectrum, remote sensing terminology & units, energy resources, energy interactions with earth surface features & atmosphere, atmospheric effects, satellite orbits, Sensor Resolution, types of sensors. Remote Sensing Platforms and Sensors, IRS satellites.
Remote Sensing Data Interpretation Visual interpretation techniques, basic elements, converging evidence, interpretation for terrain evaluation, spectral properties of soil, water and vegetation. Concepts of Digital image processing, image enhancements, qualitative & quantitative analysis and pattern recognition, classification techniques and accuracy estimation.

MODULE II (Introduction to GIS)

Introduction, History of GIS, GIS Components, GIS Applications in Real life, The Nature of geographic data, Maps, Types of maps, Map scale, Types of scale, Map and Globe, Co-ordinate systems, Map projections, Map transformation, Geo-referencing.

MODULE III (Database Management)

Spatial Database Management System: Introduction: Spatial DBMS, Data storage, Database
structure models, database management system, entity-relationship model, normalization
Data models and data structures: Introduction, GIS Data model, vector data structure, raster data structure, attribute data, geo-database and metadata.

MODULE IV (Spatial Data Analysis)

Spatial Data input and Editing: Data input methods – keyboard entry, digitization, scanning, conversion of existing data, remotely sensed data, errors in data input, Data accuracy, Micro and Macro components of accuracy, sources of error in GIS.
Spatial Analysis: Introduction, topology, spatial analysis, vector data analysis, Network analysis, raster data analysis, Spatial data interpolation techniques.

MODULE V (Application of Remote Sensing and GIS)

Implementing a GIS: Awareness, developing system requirements, evaluation of alternative systems, decision making using GIS.
Applications of GIS - GIS based road network planning, Mineral mapping using GIS, Shortest path detection using GIS, Hazard Zonation using remote sensing and GIS, GIS for solving multi criteria problems, GIS for business applications.

Text books

1. Remote Sensing and GIS by Basudeb Bhatta, Oxford University Press, 2nd Edition, 2011.
2. Introduction to Geographic Information systems by Kang-tsung Chang, McGraw Hill
   Education (Indian Edition), 7th Edition, 2015.
3. Fundamentals of Geographic Information systems by Michael N. Demers, 4th Edition, Wiley Publishers, 2012.

Reference books

1. Remote Sensing and Image Interpretation by Thomas M. Lillesand and Ralph W. Kiefer, Wiley Publishers, 7th Edition, 2015.
2. Geographic Information systems – An Introduction by Tor Bernhardsen, Wiley India Publication, 3rd Edition, 2010.
3. Advanced Surveying: Total Station, GIS and Remote Sensing by Satheesh Gopi, R. Sathi Kumar, N. Madhu, Pearson Education, 1st Edition, 2007.
4. Textbook of Remote Sensing and Geographical Information systems by M. Anji Reddy.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36 hours)
	MODULE I (8 Hours)	

1.1	Concepts of Remote Sensing Basics of remote sensing- elements involved in remote sensing.	1
1.2	Electromagnetic spectrum, remote sensing terminology & units, energy resources.	1
1.3	energy interactions with earth surface features & atmosphere, atmospheric effects, satellite orbits.	1
1.4	Sensor Resolution, types of sensors. Remote Sensing Platforms and Sensors, IRS satellites.	1
1.5	Remote Sensing Data Interpretation Visual interpretation techniques, basic elements, converging evidence.	1
1.6	interpretation for terrain evaluation, spectral properties of soil, water and vegetation.	1
1.7	Concepts of Digital image processing, image enhancements, qualitative analysis.	1
1.8	Quantitative analysis and pattern recognition, classification techniques and accuracy estimation.	1
MODULE II (7 Hours)		
2.1	Introduction, History of GIS.	1
2.2	GIS Components, GIS Applications in Real life.	1
2.3	The Nature of geographic data, Maps.	1
2.4	Types of maps, Map scale.	1
2.5	Types of scale, Map and Globe.	1
2.6	Co-ordinate systems, Map projections.	1
2.7	Map transformation, Geo-referencing.	1
MODULE III (7 Hours)		
3.1	Spatial Database Management System: Introduction: Spatial DBMS.	1
3.2	Data storage, Database structure models.	1
3.3	Database management system, entity-relationship model, normalization.	1
3.4	Data models and data structures: Introduction.	1
3.5	GIS Data model, vector data structure.	1
3.6	Raster data structure, attribute data.	1
3.7	Geo-database and metadata.	1
MODULE IV (7 Hours)		
4.1	Spatial Data input and Editing: Data input methods – keyboard entry, digitization.	1
4.2	Scanning, conversion of existing data, remotely sensed data.	1

4.3	Errors in data input, Data accuracy.	1
4.4	Micro and Macro components of accuracy, sources of error in GIS.	1
4.5	Spatial Analysis: Introduction, topology, spatial analysis.	1
4.6	Vector data analysis, Network analysis.	1
4.7	Raster data analysis, Spatial data interpolation techniques.	1
MODULE V (7 Hours)		
5.1	Implementing a GIS: Awareness, developing system requirements.	1
5.2	Evaluation of alternative systems, decision making using GIS.	1
5.3	Applications of GIS, GIS based road network planning.	1
5.4	Mineral mapping using GIS.	1
5.5	Shortest path detection using GIS.	1
5.6	Hazard Zonation using remote sensing and GIS.	1
5.7	GIS for solving multi criteria problems, GIS for business applications.	1
CO Assessment Questions		
CO1	Explain the elements involved in remote sensing.	
CO2	Discuss the map projection used in remote sensing.	
CO3	Differentiate vector data model and raster data model.	
CO4	Discuss the various errors in data input.	
CO5	Explain the application of Geographic Information System.	

24CE0822	SOIL AND WATER CONSERVATION ENGINEERING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The primary objective of this course is to provide students with a thorough understanding of erosion, ensuring they grasp the intricacies and challenges associated with this natural process. The course focusses on the principles and concepts of erosion, offering a comprehensive exploration that encompasses various problems linked to soil and water management. Ultimately, the desired outcome is to empower students with the capability to apply their acquired knowledge, enabling them to effectively address and solve issues related to soil and water management.

Prerequisite: Nil

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

CO 1	Discuss soil erosion and its various forms (Understand)
CO 2	Estimate soil loss due to erosion (Apply)
CO 3	Describe various erosion control measures (Understand)
CO 4	Design erosion control measures (Apply)
CO 5	Discuss the various aspects of wind erosion and control measures(Understand)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2						2					
CO 2	2	2					2					
CO 3	3						3					
CO 4	2	2	3				2					
CO 5	2						2					

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Soil erosion)

Soil erosion - Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion. Water erosion - Mechanics and forms - splash, sheet, rill, gully, ravine and stream bank erosion. Gullies - Classification, stages of development

MODULE II (Estimation of soil loss)

Soil loss estimation – Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity - estimation by KE>25 and EI30 methods. Soil erodibility - topography, crop management and conservation practice factors. Measurement of soil erosion - Runoff plots, soil samplers.

MODULE III (Water erosion control strategies)

Water erosion control measures - agronomical measures - contour farming, strip

cropping, conservation tillage and mulching. Engineering measures– Bunds and terraces. Bunds - contour and graded bunds - design and surplussing arrangements. Terraces - level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stonewall and trenching.
MODULE IV (Erosion mitigation & Land Restoration)
Gully and ravine reclamation - principles of gully control - vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Use of Geotextiles in soil and water conservation
MODULE V (Wind erosion)
Wind erosion- Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes. Land capability classification. Rate of sedimentation, silt monitoring and storage loss in tanks

Text books

1. Glenn O. Schwab, Delmar D. Fangmeier, William J. Elliot, and Kenneth G. Renard.2015. Soil and Water Conservation Engineering. John Wiley & Sons Inc.

Reference books

1. Mahnot, S.C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi.
2. Mal, B.C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
3. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
4. Murthy, V.V.N. 2002.Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
5. Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York,
6. USA. Frevert, R.K., G.O. Schwab, T.W. Edminster and K.K. Barnes. 2009. Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York.
7. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
8. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours (34)
MODULE 1 (6 hours)		
1.1	Introduction, causes and types - geological erosion	1
1.2	Introduction, causes and types-accelerated erosion and agents causing erosion	1
1.3	Water erosion-mechanism	1
1.4	Water erosion-forms-splash, sheet, rill	1
1.5	Water erosion-forms-, gully, ravine and stream bank erosion	1
1.6	Gullies - Classification	1
1.7	Gullies-stages of development	1
MODULE II (8 hours)		
2.1	Soil loss estimation – Universal soil loss equation (USLE)	1
2.2	Soil loss estimation- modified USLE	1
2.3	Rainfall erosivity - estimation by KE>25	1
2.4	Rainfall erosivity- estimation by EI30 methods	1
2.5	Soil erodibility - topography, crop management	1
2.6	Soil erodibility- conservation practice factors	1
2.7	Measurement of soil erosion - Runoff plots	1
2.8	Measurement of soil erosion- soil samplers	1
MODULE III (6 hours)		
3.1	Water erosion control measures	1
3.2	Agronomical measures- - contour farming	1

3.3	Strip cropping, conservation tillage and mulching.	1
3.4	Engineering measures– Bunds and terraces	1
3.5	Bunds - contour -design and surplussing arrangement	1
3.6	Graded bunds - design and surplussing arrangements	1
MODULE IV (8 hours)		
4.1	Gully and ravine reclamation - Principles of gully control	1
4.2	Principles of gully control	1
4.3	Gully and ravine reclamation-vegetative measures	1
4.4	Gully and ravine reclamation- temporary structures	1
4.5	Gully and ravine reclamation-Diversion drains	1
4.6	Grassed waterways and design	1
4.7	Grassed waterways and design	1
4.8	Use of Geotextiles in soil and water conservation	1
MODULE V (6 hours)		
5.1	Wind erosion- Factors affecting, mechanics	1
5.2	Soil loss estimation	1
5.3	Control measures- vegetative, mechanical measures	1
5.4	Wind breaks and shelter belts and stabilization of sand dunes.	1
5.5	Land capability classification. Rate of sedimentation	1
5.6	Silt monitoring and storage loss in tanks.	1

CO Assessment Questions	
CO1	List the recommendations made by Heed towards the construction of temporary structures used for the control of gully erosion.
CO2	In a 20-ha catchment, the soil erosion is to be evaluated. The following information for the catchment is available. R = 1000 t-m/ha mm/h; K = 0.25 t/ha/R; LS = 0.1; vegetative cover factor = 0.5; Contour farming is practiced in 12 -ha (P=0.6) and strip cropping is practiced in the remaining area (P=0.3). (i) Calculate the soil loss using USLE and (ii) Calculate the annual soil loss when no such conservation measure is being taken up
CO3	Sketch the typical sections of a contour bund and an outward sloping bench terrace stating the differences.
CO4	Design a grassed waterway which is to be constructed as an outlet for a flow from a graded bund system. The expected runoff is $3m^3$ /sec. The type of grass to be used is Bermuda grass. The slope of the parabolic channel is kept as 3%.
CO5	1. Explain the factors affecting wind erosion and its adverse effects. 2. Discuss the concept of wind erosion control and explain the vegetative control measures.

24CEO832	MODERN CONSTRUCTION MATERIALS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: Goal of this course is to expose the students to the recent developments in the modern construction materials, and to introduce the conventional construction materials and their modern use. This course includes various sustainable, smart, structural and non-structural materials used for the construction. After this course, students will be able to identify and decide the material most suited for the construction, considering the durability, sustainability and economy in the material selection.

Prerequisite: 24CET407 Construction Technology.

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

CO1	Describe various concrete types for specific constructions. (Understand Level)
CO2	Compare various structural materials for construction. (Understand Level)
CO3	Discuss non-structural materials used in buildings. (Understand Level)
CO4	Recall sustainable materials for construction. (Remember Level)
CO5	Describe various smart materials suitable for structures. (Remember Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	1	-	-	-	-	-
CO2	2	-	-	-	-	-	1	-	-	-	-	-
CO3	2	-	-	-	-	-	1	-	-	-	-	-
CO4	2	-	-	-	-	-	2	-	-	-	-	-
CO5	2	-	-	-	-	-	1	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L- T]**			**Total Marks**
		Assignment	**Test 1**	**Test-2**	
3-0-0-0	**5**	**15**	**10**	**10**	**40**

Total Marks distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Advanced Concrete)

Concrete - special concretes for specific purposes like lightweight concrete, ready mixed concrete, high performance concrete, self-compacting concrete, fibre reinforced concrete, polymer concrete, geopolymer concrete, ferrocement (brief description of composition, properties, and applications of the above).

MODULE II (Structural Materials)

Bricks, fly ash bricks - Stone; Stabilised mud blocks, soil - cement blocks, calcium silicate bricks, red mud - Wood, Industrial Products which can substitute wood: particle board, fibre board, hard board, Glulam - Polymers; Fibre reinforced polymers - Metals; Steel; Aluminium - Bituminous materials – Glass.

MODULE III (Non-Structural Materials)

Properties and use of conventional and modern waterproofing materials, Conventional and modern insulating materials (thermal, sound and electrical insulating materials). Concept of polymer floor finishes, paints, tiles.

MODULE IV (Sustainable Materials)

Sustainable Construction Materials - Wood, bamboo, straw bales, earthen materials, glass cullet, copper slag, municipal incinerated bottom ash, recycled aggregates, recycled plastic products, sustainable concrete, bio composites, thatched roofing, linoleum flooring. Introduction to Life Cycle Assessment (brief discussion only).

MODULE V (Smart and Intelligent Materials)

Types - Neoprene, Bridge pads, thermocol - Smart and Intelligent Materials, Special features: - Shape Memory Alloys (SMAs), Magneto strictive materials, Piezoelectric materials, Electrochromic materials, Green materials including biomaterials, biopolymers, bioplastics – Case studies showing the applications of smart and intelligent materials.

Text books

1. Building Materials, P. C. Varghese, Prentice-Hall India, 2005.
2. Concrete: Microstructure, properties and materials, P.K. Mehta and P.J.M. Monteiro, McGraw Hill, 2006.
3. Properties of concrete, A.M. Neville, Pearson, 2004.
4. Concrete Technology, Shetty M. S., S. Chand & Co., 2006.
5. Materials Science and Engineering, V. Raghavan, Prentice Hall, 1990.

Reference books

1. Construction materials: Their nature and behaviour, Eds. J.M. Illston and P.L.J. Domone, 3rd ed., Spon Press, 2001.
2. The Science and Technology of Civil Engineering Materials, J.F. Young, S. Mindess, R.J. Gray & A. Bentur, Prentice Hall, 1998.
3. Materials for Civil and Construction Engineers, Michel S. Mamlouk and John P. Zaniewski, Prentice Hall.
4. Building Materials Technology, L. Reed Brantley and Ruth T Brantley, McGraw- Hill Publishers.
5. Civil Engineering Materials, Neil Jackson and Ravindra K. Dhir, Palgrave Foundations.
6. Construction Materials and Processes, Don A. Watson, Career Education.
7. Smart Materials and Structures, Gandhi M. V. and B. S. Thompson, Chapmann & Hall, London.
8. Concrete: Microstructure, properties and materials, P.K. Mehta and P.J.M. Monteiro, McGraw Hill, 2006.
9. Modern Construction Materials, Ganapathy, C., Eswar Press, 2015.
10. Materials for civil and Highway Engineers, Deucher, K.N, Korfiatis, G.P and Ezeldin, A.S, Prentice Hall Inc., 1998.
11. Smart Structure and Materials, Brain Culshaw, Artech House – Borton. London-1996.

12. Sustainable Construction, Sandy Halliday, Butterworth-Heinemann, 2008.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
MODULE I (7 hours)		
1.1	Review of properties of concrete, uses of concrete.	1
1.2	Lightweight concrete, Ready mixed concrete. (types, properties and uses)	1
1.3	High performance concrete, Self-compacting concrete. (properties, tests and uses)	1
1.4	Fibre reinforced concrete (properties and applications).	1
1.5	Polymer concrete (types, properties and uses).	1
1.6	Geopolymer concrete (brief description of one part and two part geopolymer concrete, composition, properties, and uses).	1
1.7	Ferrocement (construction, properties and applications).	1
MODULE II (7 hours)		
2.1	Bricks, fly ash bricks , light weight concrete/aerated cement concrete block.	1
2.2	Stone; Stabilised mud blocks, soil.	1
2.3	Cement blocks, calcium silicate bricks, red mud.	1
2.4	Wood, Industrial Products which can substitute wood – particle board, fibre board, hard board, Glulam.	1
2.5	Polymers; Fibre reinforced polymers.	1
2.6	Metals – Steel, Aluminium.	1
2.7	Bituminous materials, Glass.	1
MODULE III (6 hours)		
3.1	Properties and use of conventional waterproofing materials.	1
3.2	Properties and use of modern waterproofing materials.	1
3.3	Conventional and modern insulating materials (thermal).	1

3.4	Sound and electrical insulating materials.	1
3.5	Concept of polymer floor finishes.	1
3.6	Paints, Tile.	1
MODULE IV (8 hours)		
4.1	Sustainable Construction Materials - Wood, bamboo, straw bales (characteristics, types and uses).	1
4.2	Earthen materials - rammed earth, earthen bags, mudbrick, adobe, cob, compressed earth block, (characteristics, types and uses).	1
4.3	Earth shelter technique.	1
4.4	Glass cullet, copper slag, municipal incinerated bottom ash. (characteristics and uses)	1
4.5	Recycled aggregates. (characteristics, types and uses)	1
4.6	Recycled plastic products. (characteristics, types and uses)	1
4.7	Sustainable concretes, thatched roofing, linoleum flooring. (characteristics, types and uses)	1
4.8	Introduction to Life Cycle Assessment. (brief discussion)	1
MODULE V (8 hours)		
5.1	Types- Neoprene.	1
5.2	Bridge pads, Thermocol.	1
5.3	Smart and Intelligent Materials.	1
5.4	Shape Memory Alloys (SMAs), Magnetostrictive Materials.	1
5.5	Piezoelectric Materials, Electrochromic materials.	1
5.6	Green materials including biomaterials.	1
5.7	Biopolymers, bioplastics.	1
5.8	Case studies showing the applications of smart and Intelligent Materials.	1

CO Assessment Questions	
CO1	1. Explain the mix composition, properties and uses of high performance concrete. 2. Discuss the various advantages of using self-compacting concrete. 3. Describe the properties and uses of fibre reinforced concrete. 4. Explain ready mixed concrete. What are its advantages?
CO2	1. Explain the types and properties of structural materials. 2. Describe the manufacturing process of various structural materials. 3. Identify the applications of various structural materials in construction.
CO3	1. Explain the types and properties of non-structural materials. 2. Describe the manufacturing process of various non-structural materials. 3. Summarize the uses and applications of various non - structural materials in construction.
CO4	1. Enumerate the pros and cons of various sustainable materials. 2. List out the uses and applications of various sustainable materials in construction. 3. Define the concepts of life cycle assessment.
CO5	1. Describe the pros and cons of various smart materials. 2. Enumerate the applications of smart materials in construction.

OPEN ELECTIVE – 3

24CEO813	DISASTER PREPAREDNESS AND MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The aim of this course is to inculcate a basic understanding of disaster preparedness, mitigation, recovery, and response strategies to be adopted before, during, and after the occurrence of a disaster or hazard. This course covers hazard types, mapping, risk assessment, disaster risk management, disaster response, various legislations, and best practices for disaster management. The students will be able to apply the knowledge related to disaster management practices and regulations in the context of a disaster/hazard.

Prerequisite: Nil

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

CO 1	Define various terminologies in disaster management and understand the relation of these terms in disaster management cycle (Remember and Understand level)
CO 2	Distinguish between different hazard types and vulnerability types and do vulnerability assessment (Understand level)
CO 3	Identify the components and describe the process of risk assessment, and apply appropriate methodologies to assess risk (Understand level)
CO 4	Identify the core elements and phases of Disaster Risk Management and develop possible measures to reduce disaster risks across sector and community (Understand level)
CO 5	Interpret factors that determine the nature of disaster response and discuss the various disaster response actions (Understand level)
CO 6	Explain the various legislations and best practices for disaster management and risk reduction at national and international level (Understand level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	2	-	-	-	-	2	2	-	-	-	-	-
CO 2	2	-	-	-	-	2	2	-	-	-	-	-
CO 3	2	-	-	-	-	2	2	-	-	-	-	-
CO 4	2	-	-	-	-	2	2	-	-	-	-	-
CO 5	2	-	-	-	-	2	2	-	-	-	-	-
CO 6	2	-	-	-	-	2	2	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply			✓	
Analyse				

Evaluate				
Create				

Mark Distribution of CIA

Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution

Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Systems of Earth)

Lithosphere - composition, rocks, soils; Atmosphere - layers, ozone layer, greenhouse effect, weather, cyclones, atmospheric circulations, Indian Monsoon; hydrosphere - Oceans, inland water bodies; biosphere. Definition and meaning of key terms in Disaster Risk Reduction and Management - disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment.

MODULE II (Hazard Types, Mapping and Risk Assessment)
Hazard types and hazard mapping; Vulnerability types and their assessment - physical, social, economic and environmental vulnerability. Disaster risk assessment – approaches, procedures.
MODULE III (Disaster Risk Management and Disaster Response)
Disaster risk management - Core elements and phases of Disaster Risk Management. Measures for Disaster Risk Reduction – prevention, mitigation, and preparedness. Disaster response - objectives, requirements; response planning; types of responses. Relief; international relief organizations.
MODULE IV (Disaster Communication)
Participatory stakeholder engagement; Disaster communication - importance, methods, barriers; Crisis counselling. Capacity Building: Concept – Structural and Non-structural Measures, Capacity Assessment; Strengthening Capacity for Reducing Risk.
MODULE V (Common Disaster Types in India)
Common disaster types in India; Legislations in India on disaster management; National disaster management policy; Institutional arrangements for disaster management in India. The Sendai Framework for Disaster Risk Reduction- targets, priorities for action, guiding principles.

Text books

1. R. Subramanian, Disaster Management, Vikas Publishing House, 2018.
2. M. M. Sulphey, Disaster Management, PHI Learning, 2016.
3. UNDP, Disaster Risk Management Training Manual, 2016.

Reference books

1. United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster Risk Reduction 2015-2030, 2015.
2. S. Vaidyanathan, An Introduction To Disaster Management Natural Disasters And Man Made Hazards, CBS Publishers, 2020.
3. A.K. Shrivastava, Disaster Management, Scientific Publishers, 2021.
4. I. Sundar, T. Sezhiyan, Disaster Management, Sarup and Sons Publishers, 2007.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE 1 (9 hours)	
1.1	Introduction about various Systems of earth, Lithosphere composition, rocks.	1
1.2	Soils; Atmosphere-layers, ozone layer, greenhouse effect, weather.	1

1.3	Cyclones, atmospheric circulations, Indian Monsoon; hydrosphere Oceans, inland water bodies; biosphere.	1
1.4	Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard.	1
1.5	Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard.	1
1.6	Exposure, vulnerability, risk, risk assessment, risk mapping.	1
1.7	Capacity, resilience, disaster risk reduction, Disaster risk management, early warning systems.	1
1.8	Disaster preparedness, disaster prevention, disaster mitigation.	1
1.9	Disaster response, damage assessment, crisis counselling, needs Assessment.	1
MODULE II (6 hours)		
2.1	Various Hazard types, Hazard mapping; Different types of Vulnerability types and their assessment.	1
2.2	Vulnerability assessment and types, Physical and social vulnerability.	1
2.3	Economic and environmental vulnerability, Core elements of disaster risk assessment.	1
2.4	Core elements of disaster risk assessment.	1
2.5	Components of a comprehensive disaster preparedness strategy approaches, procedures.	1
2.6	Different disaster response actions.	1
MODULE III (7 hours)		
3.1	Introduction to Disaster risk management, Core elements of Disaster Risk Management.	1
3.2	Phases of Disaster Risk Management, Measures for Disaster Risk Reduction.	1
3.3	Measures for Disaster Risk Reduction.	1
3.4	Measures for Disaster prevention, mitigation, and preparedness.	1
3.5	Disaster response- objectives, requirements.	1
3.6	Disaster response planning; types of responses.	1
3.7	Introduction - Disaster Relief, Relief; international relief organizations.	1
MODULE IV (8 hours)		

4.1	Participatory stakeholder engagement.	1
4.2	Importance of disaster communication.	1
4.3	Disaster communication- methods, barriers, crisis counselling.	1
4.4	Crisis counselling.	1
4.5	Introduction to Capacity Building.	1
4.6	Concept – Structural Measures, on-structural Measures.	1
4.7	Introduction to Capacity Assessment, Capacity Assessment.	1
4.8	Strengthening, Capacity for Reducing Risk.	1
MODULE V (6 hours)		
5.1	Introduction - Common disaster types in India.	1
5.2	Common disaster legislations in India on disaster management.	1
5.3	National disaster management policy, Institutional arrangements for disaster management in India.	1
5.4	Institutional arrangements for disaster management in India.	1
5.5	The Sendai Framework for Disaster Risk Reduction and targets.	1
5.6	The Sendai Framework for Disaster Risk Reduction - priorities for action, guiding principles.	1

CO Assessment Questions	
1	1. Describe the mechanism by which stratospheric ozone protects earth from harmful UV rays? 2. List the different types of cyclones and the mechanism of their formation. 3. Define the following terms in the context of disaster management (i) exposure (ii) resilience (iii) disaster risk management (iv) early warning systems, (v) damage assessment (vi) crisis counselling (vii) needs assessment.
2	1. Describe about hazard mapping? Describe its objectives? 2. Describe about participatory hazard mapping and how it is conducted? Explain the types of vulnerabilities and the approaches to assess them.

3	1. Explain briefly the concept of 'disaster risk' 2. Explain the strategies for disaster risk management 'before', 'during' and 'after' a disaster. 3. Describe about disaster preparedness? Describe the components of a comprehensive disaster preparedness strategy.
4	1. Differentiate disaster prevention and disaster mitigation giving examples 2. Describe the steps to effective disaster communication? Explain about the barriers to communication? 3. Explain capacity building in the context of disaster management
5	1. Explain the levels of stakeholder participation in the context of disaster risk reduction. 2. Explain the importance of communication in disaster management. 3. Explain the benefits and costs of stakeholder participation in disaster management.
6	1. Explain the salient features of the National Policy on Disaster Management in India. 2. Explain the guiding principles and priorities of action according to the Sendai Framework for Disaster Risk Reduction. 3. Describe about Tsunamis and how they are caused?

24CEO823	VIBRATION ENGINEERING	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The objective this course is to expose students to the fundamentals of vibration engineering. The course focuses on imparting knowledge of dynamic analysis of single-degree, multi-degree and distributed systems. After this course, students will be able to model physical systems for dynamic analysis and perform free and forced vibration analysis.

Prerequisite: Nil

Course Outcomes:

	After the completion of the course the student will be able to
CO1	Model systems for dynamic analysis. [Apply Level]
CO2	Develop equation of motion of single and multi-degree of freedom systems. [Apply Level]
CO3	Perform dynamic analysis of single and multi-degree of freedom systems. [Apply Level]
CO4	Analyse and design vibration isolation systems. [Apply Level]
CO5	Perform free vibration analysis of simply supported beams. [Apply Level]

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	3	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test 2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L-T]			Total Marks
		Assignment	Test-1	Test-2	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 Hours

End Semester Examination [ESE] Pattern			
Pattern	**Part A**	**Part B**	**ESE Marks**
PATTERN 1	10 Questions, each question carries 2 marks Marks: (2×10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5×8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

Module I (Single Degree of Freedom Systems – Free Vibration)

Introduction to structural dynamics and its importance in engineering applications. Dynamic loading, Parameters of a dynamic system. Degree of freedom of a dynamic system, SDOF, MDOF and continuous systems.

D'Alembert's principle – Equation of motion of SDOF spring-mass systems. Equation of motion of general SDOF systems.

Free vibration analysis of SDOF systems. Measurement of damping – logarithmic decrement.

Module II (SDOF Systems – Forced Vibration)

Response of SDOF systems to harmonic load. Transient and steady state responses, Dynamic magnification factor - Measurement of damping – half power bandwidth method.

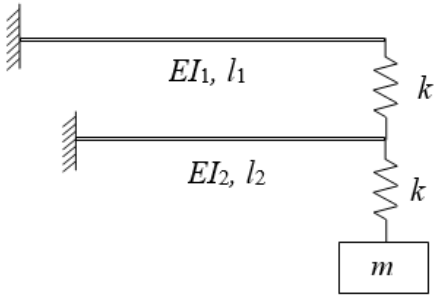
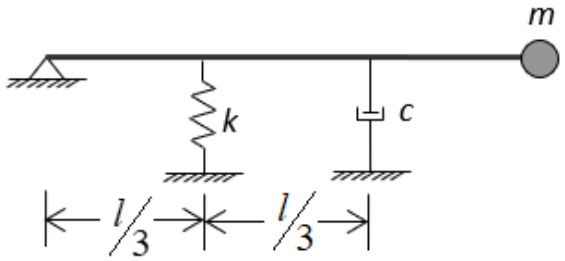
Impulse response function (IRF), Duhamel Integral - undamped and damped systems.

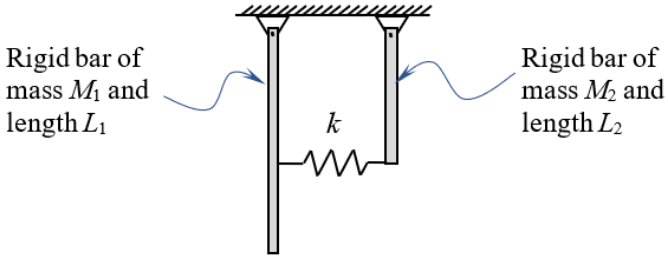
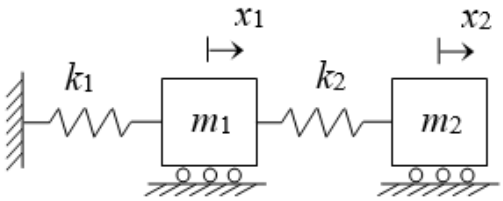
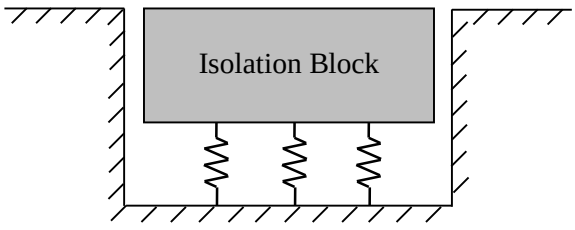
SDOF system subjected to support motion.
Module III (Vibration Isolation, Multi-Degree of Freedom Systems – Free Vibration)
Vibration isolation, Transmissibility, Design of vibration isolation systems. Vibration absorber – Tuned Mass Damper (concept only). Vibration measuring instruments. Introduction to MDOF systems – equations of motion, spring-mass models - undamped free vibration - Natural frequencies and mode shapes. Orthogonality of modes.
Module IV (MDOF Systems – Forced Vibration, Numerical Evaluation of Dynamic Response)
Forced vibration analysis of MDOF systems – Mode superposition method. MDOF system subjected to support motion. Numerical evaluation of dynamic response – time stepping methods, Numerical solution of SDOF systems using central difference method.
Module 5 (Distributed Parameter Systems, Variational Formulation)
Introduction to distributed parameter systems – differential equation for beam flexure. Natural frequencies and mode shapes of simply supported beam. Natural frequencies of cantilever and fixed beams (formulation only). Introduction to variational formulation, Hamilton's principle, Lagrange's equation.
Text books 1. Mario Paz, Structural Dynamics – Theory and Computation, CBS Publishers and Distributors, Delhi. 2. Mukhopadhyay M, Structural Dynamics - Vibrations and Systems, Ane Books, India, Delhi. **Reference books** 1. Clough R W and Penzien J, Dynamics of Structures, McGraw Hill, New Delhi. 2. Biggs J M, Introduction to Structural dynamics, McGraw Hill, New Delhi. 3. Humar J, Dynamics of Structures, CRC Press, Netherlands. 4. Roy R Craig, Structural Dynamics – An Introduction to Computer Method, John Wiley & Sons, New York. 5. Thomson W T, Theory of Vibration with Application, Pearson Education, New Delhi. 6. Weaver W, Timoshenko S P, Young D H, Vibration Problems in Engineering, John Wiley & Sons, USA.

COURSE CONTENTS AND LECTURE SCHEDULE		
No.		No. of Hours 36
Module I (8 Hours)		
1.1	Introduction to structural dynamics and its importance in engineering applications. Dynamic loading, Parameters of a dynamic system.	1

1.2	Degree of freedom of a dynamic system. SDOF, MDOF and continuous systems. Computation of stiffness of SDOF systems.	1
1.3	D'Alembert's principle – Equation of motion of SDOF spring-mass systems. Equation of motion of general SDOF systems.	1
1.4	Undamped free vibration analysis of SDOF systems. Concept of natural frequency.	1
1.5	Working out problems – undamped free vibration.	1
1.6	Free vibration analysis of damped systems.	1
1.7	Measurement of damping – logarithmic decrement.	1
1.8	Working out problems – damped free vibration.	1
Module II (7 Hours)		
2.1	Response of SDOF systems to harmonic load. Transient and steady state responses.	1
2.2	Dynamic magnification factor - Measurement of damping – half power bandwidth method.	1
2.3	Working out problems - SDOF systems to harmonic load.	1
2.4	Impulse response function (IRF) – undamped and damped systems.	1
2.5	Duhamel Integral – undamped and damped systems.	1
2.6	SDOF system subjected to support motion, equation of motion.	1
2.7	Working out problems - SDOF systems to support motion.	1
Module III (8 Hours)		
3.1	Vibration isolation – force isolation and displacement isolation.	1
3.2	Transmissibility, Design of vibration isolation systems.	1
3.3	Vibration absorber – Tuned Mass Damper (concept only). Vibration measuring instruments.	1
3.4	Introduction to MDOF systems – equations of motion.	1
3.5	Spring mass models - derivation of equations of motion.	1
3.6	Undamped free vibration - Natural frequencies and mode shapes.	1
3.7	Orthogonality of mode shapes – proof.	1
3.8	Working out problems – Natural frequencies and mode shapes of MDOF systems.	1
Module IV (7 Hours)		
4.1	Forced vibration analysis of MDOF systems – Mode superposition method	1
4.2	Forced vibration analysis of 2d systems.	1
4.3	MDOF system subjected to support motion - equation of motion.	1
4.4	Analysis of MDOF system due to support motion.	1
4.5	Working out problems – MDOF systems subjected to support motion.	1
4.6	Numerical evaluation of dynamic response – time stepping methods.	1

4.7	Numerical solution of SDOF systems using central difference method.	1
Module V (6 Hours)		
5.1	Introduction to distributed parameter systems – differential equation for beam flexure.	1
5.2	Beam flexure – solution of PDE.	1
5.3	Natural frequencies and mode shapes of simply supported beam.	1
5.4	Natural frequencies of cantilever and fixed beams – formulation of equations.	1
5.5	Introduction to variational formulation, Hamilton's principle.	1
5.6	Lagrange's equation, Equation of motion using Lagrange's equation.	1

CO Assessment Questions		
CO1	1	A simply supported beam of span L carries a central mass of M. If the beam has a uniform cross section with flexural rigidity EI, develop a spring-mass model of the beam.
	2	Obtain the spring-mass model of the system shown. Take m = 15 kg, l_1 = 1 m, EI_1 = 7000 Nm^2, l_2 = 0.8 m, EI_2 = 5000 Nm^2, k = 20 kN/m. 
CO2	1	A rigid bar of length l having mass μ per unit length is hinged at one end and carries a mass m at the other end. It is supported using a spring and a viscous damper as shown in figure. Derive the equation of motion for small oscillations. 
	2	Derive the equation of motion of the system shown in figure for small oscillations.

		
CO3	1	A single degree of freedom system has mass 20 kg, stiffness 12.5 kN/m and viscous damping coefficient 1.2 kNs/m. Find the response of the system due to an initial velocity of 50 mm/s. Also find the displacement at t = 1 s.
	2	Mass m_2 of the spring mass system, shown in figure, is given an initial displacement of 5 mm. Obtain the response of the system. Take m_1 = 20 kg, m_2 = 15 kg, k_1 = 1000 N/m and k_2 = 800 N/m. 
CO4	1	A sensitive instrument of weight 30 kg is spring mounted on a floor which is vibrating harmonically with an amplitude of 0.5 mm at a frequency of 10 Hz. If the stiffness of the spring is 18 kN/m and damping is 10% of critical, find the amplitude of motion of the instrument.
	2	A vibration isolation block, as shown in figure, is to be installed in a laboratory so that the vibration from adjacent factory operations will not disturb certain experiments. If the isolation block weighs 1000 kg and the surrounding floor and foundation vibrates at 1500 cycles/minute, determine the stiffness of the isolation system such that the motion of the isolation block is limited to 25% of floor vibration. Assume damping as 12%. 
CO5	1	Starting from fundamentals, find the natural frequencies and mode shapes of a simply supported beam of span L having uniform flexural rigidity EI and mass $\overline{m}$ per unit length. Sketch the mode shapes also.
	2	Formulate the equations for finding the natural frequencies for transverse vibrations of a fixed beam.

24CEO833	INTELLIGENT TRANSPORTATION SYSTEMS	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: This course aims to provide an understanding of the need for intelligent systems in the field of road transportation. It introduces the use of the latest technologies in various engineering fields to enhance the efficiency, safety, and sustainability of transportation systems. After the completion of the course, the students will be able to identify different intelligent user systems used in transportation, in comparison with the conventional methods.

Prerequisite: NIL

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

CO1	Explain the need for the intelligent transportation System (ITS) and its requirements. (Understand Level)
CO2	Identify various ITS user services and their components. (Understand Level)
CO3	Describe the appropriate tools and components in various functional areas of transportation for field conditions. (Understand Level)
CO4	Explain the importance of automated highway systems and new technology applications in autonomous vehicles. (Understand Level)
CO5	Discuss the planning and implementation of the ITS applications in contrast to the conventional methods. (Understand Level)

CO – PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	1	-	-	-	-	-	-	-	-	-
CO4	2	-	2	-	-	-	-	-	-	-	-	-
CO5	2	-	1	-	-	-	2	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	**Attendance**	**Theory [L-T]**			**Total Marks**
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	40

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

Pattern	Part A	Part B	ESE Marks
PATTERN 1	10 questions, each question carries 2 marks Marks: (2 × 10 = 20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. Marks: (5 × 8 = 40 marks)	60
	Total Marks: 20	Total Marks: [5×8 = 40 marks]	

SYLLABUS

MODULE I (ITS History, Architecture, Functional areas)

Introduction to Intelligent Transportation Systems (ITS), History of ITS, ITS developments and Indian scenario, Challenges, and opportunities in ITS.
National and regional ITS Architecture, Logical and Physical architecture, ITS System design - Components and requirements.

Introduction to ITS functional areas: Advanced Traveler Information systems (ATIS), Advanced Traffic Management Systems (ATMS), Advanced Public Transportation Systems (APTS), Automatic Vehicle Identification Systems (AVIS), Advanced Vehicle Control Systems (AVCS), Commercial Vehicle Operations (CVO), Automated Highway Systems (AHS).

MODULE II (ATIS, ATMS, APTS)

Advanced Traveler Information systems (ATIS): Pre trip information, en-route driver information, ATIS data collection techniques and dissemination mediums, Route guidance systems.

Advanced Traffic Management Systems (ATMS): Congestion Mitigation, Supply and Demand Strategy: Congestion pricing, Parking management and control, Traffic Management Centers, Access Control systems, Ramp metering, Emergency Management Systems (EMS) - Signal pre-emption, Incident management.

Advanced Public Transportation Systems (APTS): Public Transportation Management, En-route Transit Information, Personalized Public Transit, Bus Rapid Transit (BRT), Electronic payments, Expected Time of Arrivals, Applications in public transit information.

MODULE III (AVIS, AVCS, CVO)

Automatic Vehicle Identification Systems (AVIS): Electronic Toll collection and electronic payments, Automatic Vehicle Location, Automatic Vehicle Identification, Automatic Vehicle Monitoring, Geographic Information Systems, Global Positioning Systems, GPS – GIS integrations, GSM technology applications.

Advanced Vehicle Control Systems (AVCS): Longitudinal and Lateral Collision Avoidance, Intersection Collision Avoidance, Dynamic Speed Adaptation Systems, Automatic Braking and Steering System, Collision Warning System, Collision Avoidance system.

Commercial Vehicle Operations (CVO): Commercial Vehicle Electronic Clearance, Automated Roadside Safety Inspection, On-board Safety Monitoring, Commercial Vehicle Administration, Hazardous Materials Incident Response, Freight management, Weigh in motion.

MODULE IV (AHS, Smart Cars)

Automated Highway Systems (AHS): Smart roads, Communications - Infrastructure to Infrastructure, Vehicle to infrastructure, Vehicle to vehicle: case studies.

Technologies used in AHS, Integration of AHS, System Configuration, control and sensor requirements in AHS, AHS Implementation and its impact on Environment.

Smart Cars, Driverless Cars: Classifications and Technology, Application and Challenges, Artificial Intelligence (AI) for smart Transportation systems: Self-parking and Advanced cruise control.

MODULE V (ITS Planning)

Transportation Planning And ITS: -Relationships Between Problems, Conventional Approach and ITS Approach with case studies, Integration of ITS Into Transportation Planning. Issues And Challenges

Environmental, Economic and Safety Impacts of Intelligent Transportation Systems.

International ITS Programs: Applications In Bus Transport, Metro and Highways: Case Studies.
Possibilities and Challenges of ITS In India, Indian Smart Cities Mission: Case Studies.

Text books

1. Fundamentals of Intelligent Transportation Systems Planning, M.A. Chowdhury and A. Sadek, Artech House, 2010, First Edition.
2. Intelligent Transport Systems, Sarkar, Pradip Kumar, and Amit Kumar Jain, PHI Learning, 2018, First Edition.
3. Intelligent Transport Systems Standards, Bob Williams, Artech House Publishers, 2008.

Reference books

1. Ghosh, S., Leer, T.S. Intelligent Transportation Systems: New Principles and Architectures, CRC Press, 2000.
2. Perspectives on Intelligent Transportation Systems (ITS), J.M. Sussman, Springer, 2005, First Edition.
3. R.P Roess, E.S. Prassas, W.R. McShane. Traffic Engineering, Pearson Educational International, Third Edition, 2004.
4. Chris Drane and Chris Rizos, “Positioning Systems in Intelligent Transportation Systems”, Artech House Publishers, London.
5. National ITS Architecture Documentation, US Department of Transportation,2007
6. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.

COURSE CONTENTS AND LECTURE SCHEDULE

No.	Topics	No. of Hours (36)
	MODULE I (6 Hours)	
1.1	Introduction to Intelligent Transportation Systems (ITS).	1
1.2	History of ITS, ITS developments and Indian scenario.	1
1.3	Challenges, and opportunities in ITS.	1
1.4	National and regional ITS Architecture, Logical and Physical architecture	1
1.5	ITS System design - Components and requirements.	1
1.6	Introduction to ITS functional areas: ATIS, ATMS, APTS, AVIS, AVCS, CVO, AHS.	1
	MODULE II (9 Hours)	
2.1	Pre trip information, en-route driver information.	1

2.2	ATIS data collection techniques and dissemination mediums.	1
2.3	Route guidance systems.	1
2.4	Congestion Mitigation, Supply and Demand Strategy: Congestion pricing, Parking management and control.	1
2.5	Traffic Management Centers, Access Control systems, Ramp metering.	1
2.6	Emergency Management Systems (EMS) - Signal pre-emption, Incident management.	1
2.7	Public Transportation Management, En-route Transit Information.	1
2.8	Personalized Public Transit, Bus Rapid Transit. (BRT)	1
2.9	Electronic payments, Expected Time of Arrivals, Applications in public transit information.	1
MODULE III (8 Hours)		
3.1	Electronic Toll collection and electronic payments.	1
3.2	Automatic Vehicle Location, Automatic Vehicle Identification, Automatic Vehicle Monitoring.	1
3.3	Geographic Information Systems, Global Positioning Systems, GPS – GIS integrations, GSM technology applications.	1
3.4	Longitudinal and Lateral Collision Avoidance, Intersection Collision Avoidance.	1
3.5	Dynamic Speed Adaptation Systems, Automatic Braking and Steering System.	1
3.6	Collision Warning System, Collision Avoidance system.	1
3.7	Commercial Vehicle Electronic Clearance, Automated Roadside Safety Inspection, On-board Safety Monitoring.	1
3.8	Commercial Vehicle Administration, Hazardous Materials Incident Response, Freight management, Weigh in motion.	1
MODULE IV (7 Hours)		
4.1	Automated Highway Systems (AHS), Smart roads	1
4.2	Communications - Infrastructure to Infrastructure, Vehicle to infrastructure, Vehicle to vehicle: case studies.	1
4.3	Technologies used in AHS, Integration of AHS.	1
4.4	System Configuration, control, and sensor requirements in AHS.	1

4.5	AHS Implementation and its impact on the Environment.	1
4.6	Driverless Cars: Classifications and Technology, Application and Challenges.	1
4.7	Artificial Intelligence (AI) for smart Transportation systems: Self-parking and Advanced cruise control.	1
MODULE V (6 Hours)		
5.1	Transportation Planning And ITS: -Relationships Between Problems.	1
5.2	Conventional Approach and ITS Approach with case studies.	1
5.3	Integration of ITS Into Transportation Planning. Issues And Challenges.	1
5.4	Environmental, Economic and Safety Impacts of Intelligent Transportation Systems.	1
5.5	International ITS Programs: Applications In Bus Transport, Metro and Highways: Case Studies.	1
5.6	Possibilities and Challenges of ITS In India, Indian Smart Cities Mission: Case Studies.	1

CO Assessment Questions	
CO1	Describe the requirements for ITS with examples.
CO2	Discuss the need for pre-trip and en-route information systems.
CO3	Explain the role of technology applications in commercial vehicle operations.
CO4	Discuss the implementation process of AHS in Indian traffic conditions.
CO5	Explain the application of an ITS approach to a specific transportation problem and discuss how is it different from a conventional approach.

24CEO843	SOLID WASTE MANAGEMENT	L	T	P	J	S	C	Year of Introduction
		3	0	0	0	3	3	2024

Preamble: The course in solid waste management provides a comprehensive education in the principles and practices of collecting, handling, disposing of, and recycling various types of solid waste. Students will gain a deep understanding of waste management and design of waste disposal facilities. After the completion of the problem the students will be able to contribute to the development of effective waste management solutions through a blend of theoretical knowledge and practical exposure.

Prerequisite: 24MCT406 Environmental Science

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

CO1	Discuss the waste generation, characterization and management practices (Understand Level)
CO2	Describe the waste collection, sorting and transportation systems (Understand Level)
CO3	Compare the different waste-to-energy and waste treatment technologies (Understand Level)
CO4	Elaborate the various waste disposal methodologies (Understand level)
CO5	Explain the CPCB regulations for the management of hazardous waste, biomedical waste, e-waste and construction and demolition waste (Understand Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	3	1	-	-	-	-	**3**
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	2	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	3	1	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tools			End Semester Examination
	Test1	Test2	Other tools	
Remember	✓	✓		✓
Understand	✓	✓	✓	✓
Apply				
Analyse				
Evaluate				
Create				

Mark Distribution of CIA					
Course Structure [L-T-P-J]	Attendance	Theory [L- T]			Total Marks
		Assignment	**Test-1**	**Test-2**	
3-0-0-0	5	15	10	10	**40**

Total Mark distribution			
Total Marks	**CIA (Marks)**	**ESE (Marks)**	**ESE Duration**
100	40	60	3 hours

End Semester Examination [ESE]: Pattern

PATTERN	PART A	PART B	ESE Marks
PATTERN 1	10 Questions, each question carries 2 marks. Marks: (2x10 =20 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. Marks: (5x8 = 40 marks) Time: 3 hours	60
	Total Marks: 20	Total Marks: [5x8 = 40 marks]	

SYLLABUS

MODULE I (Introduction to Solid Waste Management)

Overview of solid waste management and its significance - Overview of waste management regulations and policies - Role of government agencies and stakeholders in waste management.

Waste Generation - Sources, types and composition of solid waste.
Solid waste management hierarchy - Waste minimization strategies - Recycling and Resource Recovery - Environmental and social impacts of improper waste management.

MODULE II (Waste Collection and Transportation)

Waste collection systems and equipment - Route optimization and scheduling Transfer stations and their role in waste transportation.
Waste sorting and separation techniques - Challenges and unique considerations for developing countries.
Integrated Solid Waste Management: Integrated waste management principles and approaches - Policy and planning considerations for integrated waste management - Case studies of successful integrated waste management systems.

MODULE III (Waste Treatment and Disposal)

Basics of composting and its benefits - Composting methods - Large-scale composting and its applications.
Waste-to-energy conversion technologies: incineration, gasification, pyrolysis, anaerobic digestion - Incineration processes and emissions control - Environmental and energy considerations of waste-to-energy systems
Disposal methods: Dumping, burial, land fill.

MODULE IV (Hazardous and E-waste)

Hazardous waste management: Identification and classification of hazardous waste, Storage, handling, and disposal of hazardous waste, CPCB regulations.
E-waste Management: Overview of electronic waste and its environmental impacts– CPCB regulations.

MODULE V (Management of Special Wastes)

Construction and Demolition Waste Management: overview, CPCB Guidelines for environmental management of construction and demolition waste.
Biomedical waste management – overview and regulations.
Plastic waste management.

Text books

1. Bhatia, S. C., Solid and Hazardous Waste Management. Atlantic Publishers and Distributors, New Delhi, 2007.
2. John Pitchel, Waste Management Practices -Municipal, Hazardous, and Industrial, Second Edition, CRC Press - Boca Raton, 2014.
3. CPHEEO, Ministry of Urban Development, Government of India, Manual on Municipal Solid Waste Management, New Delhi, 2000.
4. Central Pollution Control Board, GoI, Guidelines for Management of Healthcare Waste as per Biomedical Waste Management Rules, 2016.
5. Central Pollution Control Board, GoI, Guidelines on environmental management of construction & demolition (c & d) wastes, 2017.
6. Government of India Ministry of Environment, Forest and Climate Change, Hazardous and other Wastes (Management and Transboundary Movement) Rules, 2016 and subsequent amendments.

Reference books

1. George Tchobanoglous and Frank Kreith, Handbook of solid waste management, McGraw Hill publications –New York, 2002.
2. Bhide A.D. and Sundaresan, B.B, Solid Waste Management Collection, Processing and Disposal, 2001.
3. M. N. Rao, Razia Sultana, Solid and Hazardous Waste Management, Second Edition BS Publications, 2020.

COURSE CONTENTS AND LECTURE SCHEDULE

No.		No. of Hours (36)
	MODULE I (7 hours)	
1.1	Overview of solid waste management and its significance.	1
1.2	Overview of waste management regulations and policies.	1
1.3	Role of government agencies and stakeholders in waste management.	1
1.4	Waste Generation - Sources, types and composition of solid waste.	1
1.5	Solid waste management hierarchy- Waste minimization strategies and techniques.	1
1.6	Recycling and Resource Recovery.	1
1.7	Environmental and social impacts of improper waste management.	1
	MODULE II (9 hours)	
2.1	Waste collection systems and equipment.	1
2.2	Route optimization and scheduling.	1
2.3	Transfer stations and their role in waste transportation.	1
2.4	Waste sorting and separation techniques.	1
2.5	Challenges and unique considerations for developing countries.	1
2.6	Integrated waste management principles and approaches.	1
2.7	Policy and planning considerations for integrated waste management.	1

2.8	Case studies of successful integrated waste management systems.	1
2.9	Case studies of successful integrated waste management systems.	1
MODULE III (9 hours)		
3.1	Basics of composting and its benefits.	1
3.2	Composting methods and process control.	1
3.3	Large-scale composting and its applications.	1
3.4	Waste-to-energy conversion technologies: incineration, gasification.	1
3.5	Waste-to-energy conversion technologies: pyrolysis, anaerobic digestion.	1
3.6	Incineration processes and emissions control.	1
3.7	Environmental and energy considerations of waste-to-energy systems.	1
3.8	Disposal methods: Dumping, burial.	1
3.9	Disposal methods: land fill.	1
MODULE IV (6 hours)		
4.1	Identification and classification of hazardous waste.	1
4.2	Storage, handling, and disposal of hazardous waste.	1
4.3	Hazardous waste - CPCB regulations.	1
4.4	Overview of electronic waste.	1
4.5	Environmental impacts.	1
4.6	Electronic waste - CPCB regulations.	1
MODULE V (5 hours)		
5.1	Construction and Demolition Waste Management: overview.	1
5.2	Construction and Demolition Waste - CPCB Guidelines.	1
5.3	Biomedical waste management – overview.	1

5.4	Biomedical waste management regulations.	1
5.5	Plastic waste management.	1

CO Assessment Questions	
CO 1	Classify solid waste according to sources.
CO 2	Enlist and explain the equipment required for waste collection.
CO 3	Describe Bangalore method of composting with a neat sketch.
CO 4	Explain the storage and handling procedure for hazardous waste.
CO 5	Discuss the CPCB regulations for biomedical waste management.

PROJECT

24CED804	MAJOR PROJECT PHASE -II	L	T	P	J	S	C	Year of Introduction
		0	0	14	0	14	7	2024

Preamble: The goal of the course is to evoke the innovation and invention skills in students to solve real world problems by applying knowledge across domains. Through thorough studies and execution, the project intends to provide meaningful insights in to the identified problem and interpretation of results. The project will provide an opportunity to find viable solutions or to develop product, process or technology for civil engineering applications.

Prerequisite: Nil

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

CO1	Identify a problem from engineering field having practical importance, research interest or societal relevance, critically evaluate the published literature and define the objectives of the proposed work. (Analyze level)
CO2	Formulate the design and/or methodology for the execution of the work. (Apply level)
CO3	Conduct feasibility studies / preliminary analysis / modelling / simulation / experiment. (Apply level)
CO4	Plan and execute the tasks utilizing available resources within timelines, following ethical and professional norms. (Apply level)
CO5	Interpret/Validate the results and draw inferences. (Analyze and Evaluate level)
CO6	Write technical reports by following rules of scientific writing and deliver well-structured technical presentations. (Apply level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	-	-	-	3	3	-	-	3
CO2	3	3	-	3	-	-	-	-	3	-	-	3
CO3	3	3	2	3	1	-	-	-	3	3	2	3
CO4	3	3	3	3	1	-	-	3	3	3	2	3
CO5	3	2	3	-	-	-	-	-	3	3	-	3
CO6	3	-	-	-	-	-	-	3	3	3	-	-

Assessment Pattern

Bloom's Category	Continuous assessment tools		
	Evaluation 1	Evaluation 2	Evaluation 3
Remember			
Understand	✓	✓	✓
Apply	✓	✓	✓
Analyse	✓	✓	✓
Evaluate		✓	✓
Create			

Mark Distribution of CIA

Course Structure [L-T-P-J]	Project guide	Interim Evaluation	Final Evaluation	Draft Report	Final Report	Poster	Total marks
0-0-12-0	25	20	30	5	15	5	100

Total Mark distribution

Total Marks	CIA (Marks)
100	100

General guidelines

- The research-based project in the seventh semester shall be continued as the project in the eighth semester
- One third of the project shall be completed in VII semester and two third in VIII semester.

- Evaluation pattern
  - ❖ The progress of the project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.
  - ❖ All students doing a project in the eighth semester, shall prepare a Poster as part of their project highlighting their work. The poster carries 5% weightage of the total marks of the project course and to be prepared based on the guidelines issued time to time.

- Evaluation committee
  - ❖ Continuous Internal Evaluation (CIE) Committee shall comprise of three members. Guide shall be one member in the CIE committee.
  - ❖ Final Evaluation Committee shall comprise of three members- department project coordinator, guide and an external expert. The external expert shall be an academician or from industry. The industry expert is preferred.

- Internship
  - ❖ The students can opt internship during eighth semester which shall also be treated as their project in eighth semester, and shall be evaluated in the same pattern. The minimum duration of such internships shall be 3 months and above and to be approved by the concerned department.

Students who opt this internship can avail MOOCs or follow self-study mode to meet the credit requirements of the courses in the eighth semester course works mentioned in curriculum. In such cases, the statement of attendance from the organization where the student pursued his/her internship will be treated as attendance requirements for internal assessment and end semester examinations. If the student is permitted to follow self-study mode, he/she is liable to meet all the requirements such as attending internal exams and submitting the assignments and other works given by the course tutor in time.

- Students opted for internship in the eighth semester has to attend the interim and final project evaluation, by submitting the internship report. Internal internship supervisor shall be a member of project evaluation committee along with other project evaluation committee members, it is desirable that external supervisor from industry also shall be a member of evaluation committee of such students along with other project evaluation committee members.

HONOURS COURSES

24CEH819	MINI PROJECT	L	T	P	J	S	C	Year of Introduction
		0	0	0	4		4	2024

Preamble: The objective of Mini Project is to enable the student to take up an investigative study in the broad field of Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a group of five students, under the guidance of a supervisor. Mini Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. This is expected to provide a good initiation for the student(s) in Research & Development work. The assignment normally includes:

- Survey and study of published literature on the assigned topic.
- Preparing an Action Plan for conducting the investigation, including team work.
- Working out a preliminary approach to the problem relating to the assigned topic.
- Block level design documentation.
- Conducting preliminary analysis/modelling/simulation/experiment/design/ feasibility.
- Preparing a written report on the study conducted for presentation to the Department.

Prerequisite: Nil

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

CO1	Identify and synthesize problems and propose solutions to them. (Analyse Level)
CO2	Prepare work plan and liaison with the team in completing as per schedule. (Apply Level)
CO3	Validate the above solutions by theoretical calculations and through experiments. (Apply Level)
CO4	Write technical reports and develop proper communication skills. (Apply Level)
CO5	Present the data and defend ideas. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	-	-	-	3	3	-	2
CO2	3	-	-	3	-	-	-	3	-	3	3	-
CO3	3	3	3	3	3	-	-	-	-	3	-	-
CO4	-	-	-	-	3	-	-	3	3	3	-	1
CO5	3	3	3	3	-	-	-	3	-	3	3	1

Assessment Pattern

Bloom's Category	Continuous assessment tools		
	Evaluation 1	Evaluation 2	Evaluation 3
Remember			
Understand	✓	✓	✓
Apply	✓	✓	✓

Analyse	✓	✓	✓
Evaluate			
Create			

Mark Distribution of CIA

Course Structure [L-T-P-J]	Project guide	Interim Evaluation	Draft Report	Final Report	Final Evaluation	Total Marks
0-0-0-4	25	25	5	10	35	**100**

Total Mark distribution	
Total Marks	**CIA (Marks)**
100	100

General guidelines

- Mini project included in the curriculum is to achieve practical application of knowledge and skills learned from academics.
- It will be a group activity with a maximum of five members in a group, where group has to identify suitable topic in their domain.
- The progress of the mini project is evaluated based on three reviews, two internal reviews and a final review.
- A report is required at the end of the semester.

24CEH829	MINI PROJECT	L	T	P	J	S	C	Year of Introduction
		0	0	0	4		4	2024

Preamble: The objective of Mini Project is to enable the student to take up an investigative study in the broad field of Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a group of five students, under the guidance of a supervisor. Mini Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. This is expected to provide a good initiation for the student(s) in Research & Development work. The assignment normally includes:

- Survey and study of published literature on the assigned topic.
- Preparing an Action Plan for conducting the investigation, including team work.
- Working out a preliminary approach to the problem relating to the assigned topic.
- Block level design documentation.
- Conducting preliminary analysis/modelling/simulation/experiment/design/ feasibility.
- Preparing a written report on the study conducted for presentation to the Department.

Prerequisite: Nil

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

CO1	Identify and synthesize problems and propose solutions to them. (Analyse Level)
CO2	Prepare work plan and liaison with the team in completing as per schedule. (Apply Level)
CO3	Validate the above solutions by theoretical calculations and through experiments. (Apply Level)
CO4	Write technical reports and develop proper communication skills. (Apply Level)
CO5	Present the data and defend ideas. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	-	-	-	3	3	-	2
CO2	3	-	-	3	-	-	-	3	-	3	3	-
CO3	3	3	3	3	3	-	-	-	-	3	-	-
CO4	-	-	-	-	3	-	-	3	3	3	-	1
CO5	3	3	3	3	-	-	-	3	-	3	3	1

Assessment Pattern

Bloom's Category	Continuous assessment tools		
	Evaluation 1	Evaluation 2	Evaluation 3
Remember			
Understand	✓	✓	✓
Apply	✓	✓	✓

Analyse	✓	✓	✓
Evaluate			
Create			

Mark Distribution of CIA

Course Structure [L-T-P-J]	Project guide	Interim Evaluation	Draft Report	Final Report	Final Evaluation	Total Marks
0-0-0-4	25	25	5	10	35	**100**

Total Mark distribution	
Total Marks	**CIA (Marks)**
100	100

General guidelines

- Mini project included in the curriculum is to achieve practical application of knowledge and skills learned from academics.
- It will be a group activity with a maximum of five members in a group, where group has to identify suitable topic in their domain.
- The progress of the mini project is evaluated based on three reviews, two internal reviews and a final review.
- A report is required at the end of the semester.

24CEH839	MINI PROJECT	L	T	P	J	S	C	Year of Introduction
		0	0	0	4		4	2024

Preamble: The objective of Mini Project is to enable the student to take up an investigative study in the broad field of Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a group of five students, under the guidance of a supervisor. Mini Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. This is expected to provide a good initiation for the student(s) in Research & Development work. The assignment normally includes:

- Survey and study of published literature on the assigned topic.
- Preparing an Action Plan for conducting the investigation, including team work.
- Working out a preliminary approach to the problem relating to the assigned topic.
- Block level design documentation.
- Conducting preliminary analysis/modelling/simulation/experiment/design/ feasibility.
- Preparing a written report on the study conducted for presentation to the Department.

Prerequisite: Nil

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

CO1	Identify and synthesize problems and propose solutions to them. (Analyse Level)
CO2	Prepare work plan and liaison with the team in completing as per schedule. (Apply Level)
CO3	Validate the above solutions by theoretical calculations and through experiments. (Apply Level)
CO4	Write technical reports and develop proper communication skills. (Apply Level)
CO5	Present the data and defend ideas. (Apply Level)

CO - PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	-	-	-	3	3	-	2
CO2	3	-	-	3	-	-	-	3	-	3	3	-
CO3	3	3	3	3	3	-	-	-	-	3	-	-
CO4	-	-	-	-	3	-	-	3	3	3	-	1
CO5	3	3	3	3	-	-	-	3	-	3	3	1

Assessment Pattern

Bloom's Category	Continuous assessment tools		
	Evaluation 1	Evaluation 2	Evaluation 3
Remember			
Understand	✓	✓	✓
Apply	✓	✓	✓

Analyse	✓	✓	✓
Evaluate			
Create			

Mark Distribution of CIA

Course Structure [L-T-P-J]	Project guide	Interim Evaluation	Draft Report	Final Report	Final Evaluation	Total Marks
0-0-0-4	25	25	5	10	35	**100**

Total Mark distribution	
Total Marks	**CIA (Marks)**
100	100

General guidelines

- Mini project included in the curriculum is to achieve practical application of knowledge and skills learned from academics.
- It will be a group activity with a maximum of five members in a group, where group has to identify suitable topic in their domain.
- The progress of the mini project is evaluated based on three reviews, two intern reviews and a final review.
- A report is required at the end of the semester.