DEPARTMENT OF CIVIL ENGINEERING SYLLABUS

BACHELOR OF TECHNOLOGY

[2024-2025]

SMIT SIKKIM MANIPAL UNIVERSITY
SIKKIM MANIPAL INSTITUTE OF TECHNOLOGY

SIKKIM MANIPAL UNIVERSITY

FIRST YEAR B. TECH CURRICULUM 2024 Onwards (Common to all branches)

Semester	GROUP A (FIRST SEMESTER) PHYSICS GROUP						GROUP B (FIRST SEMESTER) CHEMISTRY GROUP					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
I	MA10101A	Engineering Mathematics–I	3	1	0	4	MA10101A	Engineering Mathematics–I	3	1	0	4
	CE10101A	Elements of Civil Engineering	3	0	0	3	ME10102A	Element of Mechanical Engineering	3	0	0	3
	PH10101A	Engineering Physics	3	1	0	4	CH10101A	Engineering Chemistry	3	1	0	4
	EC10101A	Basic Electronics	3	0	0	3	EE10101A	Element of Electrical engineering	3	0	0	3
	BA10101A	Communication Skills	2	0	0	2	CS10101A	Computer Programming in C	3	1	0	4
	ME10101A	Engineering Graphics	1	0	2	2	CH11001A *	Environmental Science*	1	0	0	1
	BP11001A **	Constitution of India	1	0	0	1						
	ME10401A	Workshop Practice	0	0	2	1	CS10401A	Computer Programming Lab	0	0	2	1
	PH10401A	Engineering Physics Lab	0	0	2	1	CH10401A	Engineering Chemistry Lab	0	0	2	1
			16	2	6	**21**			16	3	4	**21**
	Total Contact Hours (L + T + P)		24				Total Contact Hours (L + T + P)		23			
	***Mandatory audit course**						***Mandatory audit course**					
II	GROUP A (SECOND SEMESTER)						GROUP B (SECOND SEMESTER)					
	MA10102A	Engineering Mathematics–II	3	1	0	4	MA10102A	Engineering Mathematics–II	3	1	0	4
	ME10102A	Element of Mechanical Engineering	3	0	0	3	CE10101A	Elements of Civil Engineering	3	0	0	3
	CH10101A	Engineering Chemistry	3	1	0	4	PH10101A	Engineering Physics	3	1	0	4
	EE10101A	Element of Electrical engineering	3	0	0	3	EC10101A	Basic Electronics	3	0	0	3
	CS10101A	Computer Programming in C	3	1	0	4	BA10101A	Communication Skills	2	0	0	2
	CH11001A *	Environmental Science*	1	0	0	1	ME10101A	Engineering Graphics	1	0	2	2
							BP11001A **	Constitution of India	1	0	0	1
	CS10401A	Computer Programming Lab	0	0	2	1	ME10401A	Workshop Practice	0	0	2	1
	CH10401A	Engineering Chemistry Lab	0	0	2	1	PH10401A	Engineering Physics Lab	0	0	2	1
			16	3	6	**21**			16	2	6	**21**
	Total Contact Hours (L + T + P)		23				Total Contact Hours (L + T + P)		24			

Note: UHV–I has been introduced under Mandatory Induction Program.

B. TECH in CVIL ENGINEERING (138 credits)

THIRD SEMESTER							FOURTH SEMESTER						
Year	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Year**	**Sub. Code**	**Subject**	**L**	**T**	**P**	**C**
II	MA205A1	Engineering Mathematics – III	3	1	0	4	**II**	CE212A1	Geotechnical Engineering	3	1	0	4
	CE201A1	Strength of Materials	3	1	0	4		CE213A1	Structural Analysis – I	3	1	0	4
	CE202A1	Fluid Mechanics & Hydraulics	3	1	0	4		CE214A1	Design of RC Structures	3	1	0	4
	CE205A1	Building Materials & Concrete Tech.	3	1	0	4		CE20*A3	Program Elective-II	3	1	0	4
	CE20*A3	Program Elective-I	3	1	0	4		CE20*A3	Open Elective-II/Specialization /NCC	3	1	0	4
	CE20*A2/A8	Open Elective-I/Specialization /NCC	3	1	0	4		GN201A1	UHV-II	2	1	0	3
	CE201A4	Planning & CA Drawing of Buildings	0	0	2	1		CE203A4	Surveying Lab	0	0	2	1
	CE205A4	Material Testing Lab	0	0	2	1		CE204A4	Fluid Mechanics Lab	0	0	2	1
	CE201A5	Project Based Learning - I	0	0	2	1		CE202A5	Project Based Learning II	0	0	2	1
		Total	**18**	**6**	**6**	**27**			**Total**	**17**	**6**	**6**	**26**
FIFTH SEMESTER							**SIXTH SEMESTER**						
Year	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Year**	**Sub. Code**	**Subject**	**L**	**T**	**P**	**C**
	CE301A1	Structural Analysis - II	3	1	0	4		CE305A1	Construction Planning & Management	2	0	0	2
III	CE302A1	Engineering Hydrology	3	1	0	4	**III**	CE308A1	Design of Steel Structures	3	1	0	4
	CE306A1	Highway Engineering	3	1	0	4		CE309A1	Estimating, Costing & Valuation	3	1	0	4
	CE307A1	Public Health Engineering	3	1	0	4		CE30*A3	Program Elective-IV	3	1	0	4
	CE30*A3	Program Elective-III	3	0	0	3		CE30*A3	Program Elective-V	3	1	0	4
	CE30*A2/A8	Open Elective III / Specialization / NCC	3	1	0	4		CE30*A2/A8	Open Elective IV /Specialization	3	1	0	4
	CE301A4	Computer Aided Structural Analysis & Design	0	0	2	1		CE302A4	Environmental Engineering Lab	0	0	2	1
	CE303A4	Geotechnical Engineering Lab	0	0	2	1		CE304A4	Geoinformatics Lab	0	0	2	1
	CE301A9	Industrial Training-I**	0	0	2	1		GN302A1	Quantitative Aptitude & Logical Reasoning- II	0	0	2	1
	CE301A5	Project Based Learning III	0	0	2	1		CE302A5	Mini Project	0	0	2	1
	GN301A1	Quantitative Aptitude and Logical Reasoning-I	0	0	2	1							
		Total	**18**	**6**	**8**	**28**			**Total**	**17**	**5**	**8**	**26**

SEVENTH SEMESTER							EIGHTH SEMESTER						
Year	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Year**	**Sub. Code**	**Subject**	**L**	**T**	**P**	**C**
IV	CE40*A2/A8	Open Elective - V / Specialization	3	1	0	4	**IV**	CE40*A2/A8	Open Elective - VI / Specialization	3	1	0	4
	CE40*A2	Choice Based Elective***	3	0	0	3		CE402A6	Major Project Phase – II	0	0	24	12
	CE401A6	Major Project- Phase I	0	0	14	7							
	CE401A9	Industrial Training II**	0	0	2	1							
		Total	**6**	**0**	**16**	**15**			**Total**	**0**	**0**	**24**	**16**

*Appropriate subject code depends on selection of program elective.
**Industrial Trainings will be conducted during the summer vacations after IV and VI Semester and evaluated in V and VII Semester respectively.
*** Choice Based Elective- 1) Accountancy and Economics for Engineers
2) Safety in Construction

Prof. (Dr.) Chandrashekhar Bhuiyan
(Professor & Head)

Mr. Sajal Sarkar
(Assistant Professor –SG)

Mr. Guru Prasad Sharma
(Assistant Professor –SG)

CE 10101A1 ELEMENTS OF CIVIL ENGINEERING
[30 0 3]

(Common for First Year students of all branches)

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able

1. To understand the importance and basics of Mechanics of solids
2. To understand the application of Building materials.
3. Students will be able to understand the fundamentals of Geotechnical Engineering and foundations.
4. To understand the importance of Earthquake Engineering and its effect on structures
5. To understand the fundamentals and importance of Surveying in Transportation Engineering and Civil Engineering Projects.

MODULE 1

Fundamentals of Mechanics of Solids

Resultant of a Coplanar concurrent force system
Centroid: Concept of center of gravity, centroid of area, centroid of line, concept of line of symmetry, location of centroid by direct integration of rectangular, triangular sections, Numerical problems.
Moment of Inertia: MI of plane figure with respect to an axis in its plane, MI of plane figure with respect to an axis perpendicular to the plane of the figure; Parallel axis theorem; Mass moment of inertia of symmetrical bodies, e.g. cylinder, sphere, cone. [12]

MODULE 2

Fundamentals of Building Materials

Cement, sand, stones, bricks, mortars; Plain, Reinforced Concrete; Structural Steel, [06]

MODULE 3

Geotechnical Engineering

Basics of soil mechanics, Three phase system and parameters associated, Numerical; Basics of permeability and seepage; foundations and its types. [08]

MODULE 4

Elements of Earthquake Engineering

Plate Tectonics, Earthquake waves; Intensity and magnitude; Seismic zones in India; Earthquakes in India, causes and effects; Earthquake resistant design philosophy. [08]

MODULE 5

Surveying

Basic concepts of surveying; levelling and Area volume Calculation for earthwork. [06]

Total contact hours: **40**

References:

1. Ashok Kumar Jain and B.C. Punmia, Soil Mechanics and Foundations
2. Engineering Mechanics S.P. Timoshenko & D.H. Young
3. M. S. Shetty, Concrete Technology: Theory and Practice
4. Surveying and levelling, N.N. Basak
5. B.C. Punmia, Surveying Vol. I
6. Earthquake Resistant Design of Structure, S. K. Duggal

MA205A1 ENGINEERING MATHEMATICS – III [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

On successful completion of this course, students will be able to

1. Apply Fourier Analysis in real life problems.
2. Understand and solve partial differential equations.
3. Apply Vector calculus in hydraulic analysis.
4. Implement probability to make improvements in infrastructure projects.
5. Understand the probability distribution which the structures follow.

Module	Topics	Hrs
Module 1: **Fourier Analysis**	Periodic functions, Trigonometric Series, Fourier series, Fourier series of odd and even functions, functions with arbitrary period, half range expansion, Fourier integrals, Fourier transforms, Fourier sine and cosine transforms, Convolution theorem (statement only). Fourier sine and cosine transforms.	[08]
Module 2: **Partial Differential Equation**	Definition, degree, order of a PDE. Formation of PDE. Linear and nonlinear PDE. Solution of first order linear PDE. Lagrange's method, Charpit's method. Solution of higher order PDE by direct integration. Solution of higher order linear PDE with constant coefficients, homogeneous and non-homogeneous equations. Derivations of one-dimensional wave equation (vibrating string) and its solutions by using method of separation of variables. Solutionof2D-Laplace'sequation. Derivation of one-dimensional wave equation (vibrating string).	[10]
Module 3: **Vector Calculus**	Gradient, divergence and curl and their physical meaning and identities. Line, surface and volume integrals. Simple problems. Related problems of Line integral.	[06]
Module 4: **Probability Theory**	Introduction to Probability: Finite sample space, conditional probability and independency, Baye's theorem, one dimensional random variable, mean, variance and expectation, Chebyschev's inequality, Two and higher dimensional random variables, covariance, correlation coefficients Related problems of Random variables.	[08]
Module 5: **Probability distributions**	Least squares principle of curve fitting, Distributions: Binomial, Poisson, Uniform, Normal, Gamma, Chi square and exponential, simple problems Numerical problems related to Probability distributions.	[04]

Textbooks:

1. C. E. Weather burn: Vector Analysis, G Bells &Sons
2. P. L. Meyer, Introductory Probability and Statistical Application – Addison-Wesley Publishing Company.
3. Erwin Kreyszig: Advanced Engineering Mathematics, Wiley
4. I. Sneddon, Elements of Partial Differential Equations, Dover Publications INC
5. S.C. Gupta & V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons

Reference Books:

1. S. M. Ross: Introduction to probability and statistics for engineers and scientists, Pearson
2. Murray R. Spigel: Vector Analysis, Schaum Outline Series

CE 201A1 STRENGTH OF MATERIAL [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. To determine the resultants of coplanar Concurrent and Non-concurrent force system.
2. To find the SFD and BMD of determinate beams.
3. To solve the problems related to simple stresses and strains.
4. To evaluate bending stress and shear stress distribution in beams.
5. To analyse the problems related to torsion and compression members.

Module – 1
Coplanar Concurrent and Non-Concurrent Force System

Resultant of a force system, Concept of free body diagrams, Lami's theorem. Moment of a force, couple, properties of couples, resultant of non-concurrent force system, conditions of equilibrium, Types of Supports, Types of loads, Equilibrium equations, Reaction forces.

[08]

Module – 2
Shear force and Bending moment diagram

Shear force and Bending moment, Sign convention, Relationship between load intensity, Shear force and Bending moment, Point of Contra-flexure, SFD and BMD of beams subjected to various loads.

[07]

Module – 3
Simple Stresses and Strains

Mechanical properties of materials, concept of stresses and strains, stress-strain diagrams, yield stress, ultimate stress, limit of proportionality, elastic limit, working stress , factor of safety, Hooke's law, Young's modulus(Modulus of elasticity), rigidity modulus, bulk modulus, Poisson's ratio, relationship among the elastic constants, bars of varying cross sections, elongation due to self-weight; Numerical problems.

[08]

Module – 4
Stresses in Beams

Simple bending theory, derivation of pure bending equation, section modulus, moment of resistance, modulus of rupture, derivation of shear stress in beams, shear stress distribution across rectangular, triangular and circular sections, problems.
Stress at a point in a general two-dimensional stress system, principal stresses, principal planes, maximum shear stress, shear plane, Mohr Circle.

[10]

Module – 5
Torsion of circular Shaft and Axially loaded compression members

Pure torsion, derivation of pure equation, transmission of power, polar modulus of section, strength and stiffness of solid and hollow shafts, Equivalent moment and equivalent torque, problems.
Classification, definition of effective length, slenderness ratio, critical load, derivation of Euler's equation for a column hinged at both ends, Rankine-Gordon formula

[07]

Total Contact Hours – **40**

Reference Books:

Name of book	**Author(s)**	**Publisher(s)**
1. Strength of Materials	S.S.Bhavikatti	Vikas
2. Strength of Materials	R.K. Rajput	S. Chand
3. Strength of Materials	Khurmi&Khurmi	S. Chand
4. Strength of Materials	S.Ramamrutham	Dhanpat Rai
5. Elements of Strength of Materials	Timoshenko and Young	EWP

CE 202A1 FLUID MECHANICS & HYDRAULICS
[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Understand the significance of fluid properties and explain its effects in a flow system.
2. Describe the motion of fluid particles and use Euler's and Bernoulli's equations to solve fluid flow problems.
3. Determine the losses in flow through pipes and calculate hydraulic coefficients.
4. Solve non-uniform flow problems in open channels and calculate the discharge in free surface flows.
5. Design models and prototypes using similitude concepts and understand the theory of boundary layer and flow separation.

MODULE– 1
Properties of fluids

Specific weight, mass density, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Classification of fluids – ideal and real fluids, Newtonian and non-Newtonian fluids, compressible and incompressible fluids.

[08]

MODULE – 2
Continuity, momentum and energy equations and their applications

Introduction, methods of describing fluid motion- Lagrangian and Eulerian approach. Continuity equation in differential form in Cartesian co-ordinates, continuity equation in one dimensional flow. Euler's equation of motion in one dimension, Bernoulli's equation, limitation and modification of Bernoulli's equation. Application of Bernoulli's equation, venturi meter, orifice meter and pitot tube.

[09]

MODULE – 3
Flow through pipes

Darcy-Weisbach equation for flow through pipes, friction factor, Specialization losses, pipes in series and parallel, equivalent length, pipe network analysis. Flow through orifices and mouth pieces. Classification of orifice and mouth pieces, Hydraulic coefficients.

[10]

MODULE – 4
Open Channel Hydraulics

Introduction to free surface flow (Uniform and Non-uniform Flows), Chezy's and Manning's formulae, Classification of flow, Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles. Flow through notches and weirs, Rectangular, triangular, trapezoidal notches, broad crested weir.

[10]

Module – 5
Hydraulic Similitude and Boundary layer flow

Introduction to Dimensional Analysis, Model studies, similitudes, dimensionless parameters, significance of dimensionless numbers, Reynolds, Froude, Euler, Mach and Weber number, model laws, Reynolds law, Froude's law, undistorted and distorted models, scale effect.
Boundary layer concept, drag coefficients, control of boundary layer.

[10]

Total contact hours: **47**

Reference Books

1. Kumar K L, **Engineering Fluid Mechanics**, Tata McGraw Hill, New Delhi
2. Shames, **Mechanics of Fluids**, McGraw Hill Book Co.
3. SOM, **Fluid Mechanics and Machines**, Tata McGraw Hill New Delhi.
4. Mohanty, **Fluid Mechanics**, Prentice Hall of India, New Delhi
5. Jain A K, **Fluid Mechanics**, Khanna Publishers, New Delhi.
6. Modi P N and Seth S M, **Hydraulic and Fluid Mechanics**, Standard Book House, New Delhi.
7. Chow, Vente, **Open Channel Hydraulic**, Tata McGraw Hill Publishing, Delhi
8. Raghunath H.M, **Fluid Mechanics and Machinery**, CBS Publishers, New Delhi
9. Subramanya K, **Theory and Applications of Fluid Mechanics**, Tata McGraw Hill
10. Streeter V L and Wiley E B, **Fluid Mechanics**, McGraw Hill Co.
11. Garde R L, **Fluid Mechanics through Problems**, New Age International.

CE 205A1 BUILDING MATERIALS AND CONCRETE TECHNOLOGY [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Understand and describe need for modern techniques and new materials in construction industry and to select materials for engineering purpose is very much crucial activity based its properties, suitability, strength and durability. Component in building,
2. Illustrate and explain the main process of building construction to enrich civil engineering technicians in performing their jobs with ease and confidence and will be able to select appropriate material for the given item of work on site. Identify the various building components in detail and interpret drawing and give layout on the field of given structure construction for any building.
3. Identify and analyse the properties and role of ingredients like cement, aggregate, admixtures etc. to produce better quality concrete, admixtures and its types, workability of concrete.
4. Apply and design concrete mix, hardened concrete, and special concrete and apply design mix concepts to produce concrete with adequate strength and durability. Properties of materials, Supervise the construction work of buildings,
5. Ability to identify the current codes related to green building and green rating systems. Understand behavior and characteristics of perform destructive, semi-destructive and non-destructive tests for concrete.

MODULE 1:
Construction Materials

Tiles: For flooring, roofing and decorative – properties and uses. Lime: Properties and uses. Timber: Varieties, properties, uses, defects, seasoning and preservation. Doors and Windows Different types of doors and windows with necessary sketches. Flooring Granolithic, concrete, marble, and terrazzo flooring including methods of laying. Brick Masonries Bricks: Types, refractive and modular bricks and their application. Bonds in bricks, reinforced brick work, hollow block construction and rat trap masonry.

[09]

MODULE 2:
Components of Building

Foundations Introduction to different types of foundations – masonry footing, isolated, combined and strap, RCC footings, raft foundation, friction piles and bearing piles, caissons and coffer dams. Walls Load bearing and partition walls, damp proof construction for walls and floors. Roofing Sloped roofs – lean to, coupled and collared roofs, king post and queen post trusses. Stairs Types of R.C. stairs with sketches. Plastering and Painting Colour

washing, White washing and distempering of walls. Reinforced Concrete Construction Lintels, beams, slab, and chejjas – functions, methods of construction and detailed sketches, form work details for R.C.C. columns, beams and slabs.

[10]

MODULE 3:
Concrete Technology

Concrete Technology Fresh Concrete: Definition, Cement: Types, composition, properties and uses. Coarse aggregate and fine aggregate, properties and uses. Physical tests on ingredient of fresh concrete as per I.S. Quality of water and water cement ratio, segregation, and bleeding. Mix design, proportion, batching, workability, mixing, placing, compacting, various methods of curing, Test on fresh concrete as per IS.

[10]

MODULE 4:
Admixtures

Admixtures: A brief description on commonly used admixtures and their effects on concrete. Types, properties and uses. Effect on water cement ratio.

[05]

MODULE 5:
Properties and design of concrete

Hardened Concrete: Maturity, creep, shrinkage, Destructive and non-destructive tests as per IS: 13311 Mixed Design: as per IS: 10262.

[06]

Total contact hours: **40**

Reference Books:

1. Shetty M S**, Concrete Technology**, S. Chand and Co, New Delhi
2**. I.S Hand Book on Mix design,** BIS New Delhi
3. Punmia B C, **Building Construction**, Lakshmi Publications, New Delhi.
4., J. Brooks, **Concrete Technology**, Harlow, England ; New York : Prentice Hall, 2010.
5. S. C. Rangwala, **Engineering Materials**.

CE 201A4 PLANNING AND COMPUTER AIDED DRAWING OF BUILDINGS [0 0 2 1]

Course Outcomes (CO):

After completion of this course, students should be able to

1. Remembering the basics of Auto Cad - Command and purpose
2. Understand the idea and concept of Page layout and settings, Format, Units, Dimensions, engineering drawing.
3. Applying the different commands to draw foundations, doors and windows.
4. Understanding the concept of engineering drawing, plan, elevation and section.
5. Preparing complete set of drawings and reports.

Module 1: Introduction to Auto Cad

Preliminary introduction to Basics of Auto Cad- Command and purpose, Basic keys, Page layout and settings, Format, Units, Dimensions, Basic drawing.

Module 2: Foundations

Draw plan, elevation and sectional view for different types of foundations with details.

Module 3: Doors and Windows

Plan, elevation and sectional views for different types of doors and windows in detail.

Module 4: Plan and Elevation of Residential Buildings

Plan, and elevation of two storey residential building

Module 5: Sectional Views of Residential Buildings

Sectional views of two storey residential building

Reference Books

1. Rangwala, Civil Engineering Drawing
2. Dr. N. Kumara Swamy , A. Kameswara Rao, Building Planning and Drawing
3. A Kamal, Book of House Plans and Elevations
4. V.B. Sikka , A Course In Civil Engineering Drawing.
5. S. Vishal, AUTOCAD Drawing.
6. Gurucharan Singh and Subhash chandra, Text Book of Civil Engineering Drawing.
7. Prof. Sham Tickoo, Exploring AutoCAD Civil 2020

CE 205A4 MATERIAL TESTING LAB [0 0 2 1]

Course Outcomes (CO):

After completion of this course, students should be able to

1. Understanding the theoretical concept of various properties of construction materials.
2. Interpreting the concept of different kinds of experiments for different materials.
3. Conducting the experiments to validate the theoretical knowledge on the properties of construction materials.
4. Analyzing the results obtained from experiments and interpret the result and its deviation from normal standard if any.
5. Preparing Laboratory reports.

(a) Test on cement

1. Determination of Specific Gravity of cement.
2. Determination of fineness of cement.
3. Determination of standard consistency of cement.
4. Determination of setting times of cement.
5. Determination of soundness of cement.
6. Determination of strength of cement.

(b) Test on Fine and Coarse aggregates for concrete

1. Determination of specific gravity of fine aggregate.
2. Determination of specific gravity of coarse aggregate.
3. Determination of fineness modulus of fine aggregate.
4. Determination of fineness modulus of coarse aggregate.
5. Determination of bulking of sand.
6. Determination of clay (or silt) content in sand.

(c) Test on concrete

1. Determination of workability of concrete by slump test.
2. Determination of workability of concrete by compaction factor test.
3. Determination of workability of concrete by Vee-Bee consistometer test.
4. Determination of compressive strength of concrete.
5. Determination of tensile strength of concrete.

(d) Test on Aggregates

1. Determination of aggregate impact value.
2. Determination of aggregate abrasion value. (Los Angeles test)
3. Flakiness and Elongation indices of aggregates – demonstration
4. Rebound hammer test – demonstration.

(e) Revision of experiments

Reference Books:

1. Shetty M S, **Concrete Technology**, S Chand and Co.
2. Neville A M, **Properties of concrete**, ELBS London.
3. Gurucharan Singh, **Materials of Construction**.
4. V VShastry and M L Gamber, **Laboratory Manual of Concrete Testing Part I & II**

CE 212A1 GEOTECHNICAL ENGINEERING
[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. To remember and understand the various physical properties of soil like void ratio, dry density etc.
2. To apply the physical properties in order to calculate effective stresses.
3. To evaluate the permeability, seepage and distribution of stresses with help of the basic soil properties and effective stresses.
4. The student will be able to analyze the risk involved in construction due to excessive settlement with help of the physical properties
5. The student will be able to evaluate the shear strength of soil.

Module – 1:
Index Properties and Soil Classification

Soil as a three-phase material, physical properties of soil – specific gravity, void ratio, porosity, degree of saturation, bulk density, dry density, saturated density, relative density, moisture content, inter-relationships between them, Atterberg's limits. IS classification of soils. sieve analysis, hydrometer analysis, field identification of soils

[08]

Module – 2:
Flow through Soils

Concept of permeability, Darcy's law, factors affecting permeability, laboratory determination of permeability of soils, permeability of stratified deposits, principles of effective, neutral and total stresses, Various Cases of and their effective stress calculations and capillarity in soils.

[08]

Module – 3:
Seepage through Soils

Cases of Upward flow, Downward flow and no flow. Laplace equation (no derivation), flow nets, their properties and applications, phreatic line, piping, graded filters. quicksand condition

[08]

Module – 4:
Compaction of Soils and Stress Distribution in Soils

Optimum moisture content, maximum dry density and zero air voids line, factors affecting compaction, IS light and heavy compaction tests. Assumptions in stress distribution, limitations and comparison of Boussinesq's and Westergaard's theory for stresses in soils,

use of Boussinesq's and Westergaard's equations for determination of stress distribution (no derivation) for point load, and uniformly loaded circular and rectangular areas.

[08]

Module – 5:
Compressibility of Soils

Concept of consolidation of soils, definition of - compressibility index, coefficient of compressibility, coefficient of volume compressibility, normally consolidated, pre-consolidated, over consolidated and under consolidated soils, one dimensional consolidation – Terzaghi's theory (no derivation), consolidation test, Casagrande's method for determination of pre-consolidation pressure.

[08]

Total contact hours: **40**

Reference Books:

1. Das B M, **Principles of Geotechnical Engineering,** Cengage Learning India Pvt. Ltd
2. Punmia P C, **Soil Mechanics and Foundations**, Laxmi Publications Pvt. Ltd.
3. Murthy V N S, **A Textbook of Soil Mechanics and Foundation Engineering**, Sai Kripa Technical Consultant, Bangalore.
4. Gopal Ranjan and Rao A S R, **Basic and Applied Soil Mechanics**, New Age International
5. Terzagi K and Peck R B, **Soil Mechanics in Engineering Practice,** A Wiley International
6. Taylor D W, **Fundamentals of Soil Mechanics**, Asia Publishing House, Bombay
7. Ramiah B K and Chickanagappa L S, **Handbook of Soil Mechanics and Foundation Engineering**, Oxford and IBH
8. Lambe T W and Whitman R V, **Soil Mechanics - SI version**, John Wiley and Sons.

CE 213A1 STRUCTURAL ANALYSIS I [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. To understand the concept of indeterminacy and stability of structures.
2. Analysis of determinate beams and trusses.
3. Evaluation of shear stresses, bending stresses and combined stresses developed in structures.
4. To determine the slope and deflection of beam.
5. To understand the concept of Torsion and axially loaded Compression member and its application in real life structures.

Module 1: Introduction

Determinate and indeterminate structures, Degree of freedom, stable and unstable structures.

[04]

Module 2: Deflection of beams

Derivation of Double Integration Method, slope and deflection of statically determinate beams loaded with various type of loading. Slope and deflection by (a) Moment area method (b) Conjugate beam method.

[08]

Module 3: Strain Energy

Strain energy, strain energy due to axial force and bending moment, virtual work on rigid and elastic bodies, principle of virtual work, and Castigliano's theorem, Unit load method, Betti's theorem, Maxwell's law of reciprocal deflections, Problems.

[11]

Module 4: Analysis of Plane Trusses

Analysis of plane trusses by method of joints, method of sections, and Maxwell Diagram. Deflection of trusses by unit load method.

[10]

Module 5: Three hinged arches, Cables and Suspension bridges

Analysis of three hinged parabolic and semi-circular arches. Determination of horizontal reaction, normal thrust, radial shear and bending moment. Analytical solution of cable structure, length of a cable, three hinged suspension bridges with stiffening girder

[11]

Total Contact Hours – **44**

Reference Books:

Name of book	Author(s)	Publisher(s)
1. Strength of Materials	S.S.Bhavikatti	Vikas
2. Structural Analysis-I	S.S.Bhavikatti	Vikas
3. Elements of Strength of Materials	Timoshenko and Young	EWP
4. Theory of Structures	S. Ramamrutham	Dhanpat Rai P C
5. Theory of Structures	Pumina, Jain & Jain	LP
6. 5. Theory of Structures	Khurmi&Khurmi	S. Chand
7. Structural Analysis	R.C. Hibbler	Pearson

CE 214A1 DESIGN OF RC STRUCTURES [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Apply the direct design method to design the Flat Slab
2. Understanding the basic concepts of design for slender column.
3. Description of various methods of R.C.Design.
4. Applying the different methods to design the different kind of beams and slabs.
5. Design of compression member

Module 1:
Design by Working Stress Method

Role of reinforcement, behavior of RCC sections, Principles of design of reinforced concrete members – Straight line theory, assumptions, determination of neutral axis, determination of stress and strain due to bending moment Basic concepts of design for bending moment and shear forces - under reinforced, over-reinforced and balanced beam. Design of singly/ Doubly reinforced sections. [10]

Module 2:
Limit State Method

Principle of limit state method of design, characteristic loads, characteristic strength, partial safety factors, stress strain characteristics of concrete and steel. Introduction to stress block parameters for collapse, limit state of serviceability.

[08]

Module 3:
Limit State Design of Beams and Slabs

Design of rectangular beams (singly and doubly reinforced), design for shear and torsion. Limit state design of one way and two-way slabs for various boundary conditions.

[12]

Module 4:
Limit State Collapse in Compression

Limit state collapse in compression: design of axially loaded short RC columns of square/ rectangular cross-sections under axial loading.

[08]

Module 5:
Column footing

Types of footing, design of isolated footing.

[06]

Total Contact Hours: **44**

Reference Books:

1 Shah H J, **Reinforced Concrete Vol.I,**Charotar .
2 Sinha N.C and Roy S.K, **Fundamentals of Reinforced Concrete**, S Chand .
3 Shah N L and Karve S R, **Illustrated Reinforced Concrete Design**,
4 Karve S R and Shah Limit **state Theory and Design of Reinforced Concrete**.
5 Jain A K **Reinforced Concrete – Limit State Design**.
6. Mallick& Gupta **Reinforced concrete Design**
7. P.C. Varghese **Limit State Design of Reinforced Concrete**
8. Pillai and Menon **Reinforced Concrete Design**, Tata McGraw Hill
9. **IS 456 – 2000** Code of Practice for plain and reinforced concrete.
10. **SP-16 -1980** Design Aids for Reinforced Concrete IS 456 – 1978.

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY and ETHICAL HUMAN CONDUCT

Course Objectives:

This introductory course input is intended:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and professionaswellastowardshappinessandprosperitybasedonacorrectunderstandingof the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. TohighlightplausibleimplicationsofsuchaHolisticunderstandingintermsofethicalhuman conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

Pre-requisites: None. However, it is desired that students may have gone through UHV-I: Universal Human Values-Introduction

Course Outcome (CO):

1. Students are expected to understand self-exploration and Basic Human Aspirations.
2. To understand harmony in themselves (Human being).
3. To become more aware of their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
4. They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationships and human society). It is hopedthattheywouldbeabletoapplywhattheyhavelearnttotheirownselfindifferentday-to-day settings in real life, at least a beginning would be made in this direction.

Therefore, the course and further follow up is expected to positively impact common graduate attributes like:

1) Holistic vision of life
2) Socially responsible behaviour
3) Environmentally responsible work
4) Ethical human conduct
5) Having Competence and Capabilities for Maintaining Health and Hygiene
6) Appreciation and aspiration for excellence (merit) and gratitude for all

Module 1 –Introduction to Value Education (9 Hrs)

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)

Lecture 2: Understanding Value Education
Tutorial 1: Practice Session *PS1* *Sharing about Oneself*
Lecture 3: Self-exploration as the Process for Value Education

Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations

Tutorial 2: Practice SessionPS*2* *Exploring Human Consciousness*
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfil the Basic Human Aspirations

Tutorial 3: PracticeSessionPS*3* *Exploring Natural Acceptance*

Module 2 – Harmony in the Human Being (9 Hrs)

Lecture 7: Understanding Human being as the Co-existence of the Self and the Body

Lecture 8: Distinguishing between the Needs of the Self and the Body

Tutorial 4: Practice Session PS*4 Exploring the difference of Needs of Self and Body*

Lecture 9: The Body as an Instrument of the Self

Lecture 10: Understanding Harmony in the Self

Tutorial 5: Practice Session PS*5 Exploring Sources of Imagination in the Self*

Lecture 11: Harmony of the Self with the Body

Lecture 12: Programme to ensure self-regulation and Health

Tutorial 6: Practice Session PS*6 Exploring Harmony of Self with the Body*

Module 3 – Harmony in the Family and Society (9 Hrs)

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction

Lecture 14: 'Trust' – the Foundational Value in Relationship

Tutorial 7: Practice Session PS*7 Exploring the Feeling of Trust*

Lecture 15: 'Respect' – as the Right Evaluation

Tutorial 8: Practice Session PS*8 Exploring the Feeling of Respect*

Lecture 16: Other Feelings, Justice in Human-to-Human Relationship

Lecture 17: Understanding Harmony in the Society

Lecture 18: Vision for the Universal Human Order

Tutorial 9: Practice Session PS*9 Exploring Systems to fulfil Human Goal*

Module 4 – Harmony in the Nature/Existence (6 Hrs)

Lecture 19: Understanding Harmony in the Nature

Lecture 20: Interconnectedness, self-regulation, and Mutual Fulfilment among the Four Orders of Nature

Tutorial 10: Practice Session PS*10 Exploring the Four Orders of Nature*

Lecture 21: Realizing Existence as Co-existence at All Levels

Lecture 22: The Holistic Perception of Harmony in Existence

Tutorial 11: Practice Session PS*11 Exploring Co-existence in Existence*

Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics (9 Hrs)

Lecture 23: Natural Acceptance of Human Values

Lecture 24: Definitiveness of (Ethical) Human Conduct

Tutorial 12: Practice Session PS*12 Exploring Ethical Human Conduct*

Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order

Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS*13 Exploring Humanistic Models in Education*

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies

Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS*14 Exploring Steps of Transition towards Universal Human Order*

Content for Practice Sessions (Tutorials)

Inordertoconnectthecontentoftheproposalswithpractice(living),14practicesessionshavebe en designed. The full set of practice sessions is available in the Teacher's Manual as well as the website.

Practice Sessions for Module 1 – Introduction to Value Education

PS1 Sharing about Oneself

PS2 Exploring Human Consciousness

PS3 Exploring Natural Acceptance

Practice Sessions for Module 2 – Harmony in the Human Being

PS4 Exploring the difference of Needs of Self and Body

PS5 Exploring Sources of Imagination in the Self

PS6 Exploring Harmony of Self with the Body

Practice Sessions for Module 3 – Harmony in the Family and Society

PS7 Exploring the Feeling of Trust PS8 Exploring the Feeling of Respect

PS9 Exploring Systems to fulfil Human Goal

Practice Sessions for Module 4 – Harmony in the Nature (Existence)

PS10 Exploring the Four Orders of Nature

PS11 Exploring Co-existence in Existence

Practice Sessions for Module 5 – Implications of the Holistic Understanding – a Look at Professional Ethics

PS12 Exploring Ethical Human Conduct

PS13 Exploring Humanistic Models in Education

PS14 Exploring Steps of Transition towards Universal Human Order

Textbook

A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1

The Teacher's Manual

Teachers' Manual for *A Foundation Course in Human Values and Professional Ethics*, RR Gaur, R Asthana, GP Bagaria,2nd Revised Edition, Excel Books, New Delhi,2019. ISBN978-93-87034-53-2

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak,1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi,2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful – Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India – by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

CE 203A4 SURVEYING LAB [0 0 2 1]

Course Outcomes (CO):

After completion of this course, students should be able to

1. Understanding the practical use of different kind of surveying instruments.
2. Explaining the methods and techniques of experiments with detailed concepts.
3. By Conducting the experiments, collect data from the field to perform required calculations to achieve the objective for different types of surveying experiments.
4. Able to control the accumulation of errors in experiments.
5. Preparing Laboratory reports.

Module1: Compass Traversing

(i) construction of regular pentagon.
(ii) construction of regular hexagon.

Module 2: Leveling

(i) Simple levelling – to find out elevation of different points shown on the ground with respect to given arbitrary B.M.
(ii) To find difference in level between two points by reciprocal levelling.

Module 3: Measurement of distances and elevations:

(i) To find RL and distance when the base of object is accessible.
(ii) To find RL and distance when the base of object is inaccessible.

Module 4: Contouring using Tacheometer.

Module 5: **Curve Surveying**:

i) Simple curve using Theodolite
ii) Setting out compound curves
iii) Setting out reverse curves

Reference Books:

a. Kanetkar T P and Kulkarni S V, Surveying and Levelling Part I & II
b. Punmia B C, Surveying Vol I & II, Lakshmi Publications

CE 204A4 FLUID MECHANICS LAB [0 0 2 1]

Course Outcomes (CO):

After completion of this course, students should be able to

1. To understand the principles of fluid flow and conduct experiments to determine the associated parameters.
2. To assess the energy losses in fluid flowing through pipes
3. To impart training to use various flow measuring devices for making engineering judgments in real time flow scenarios.
4. To gain knowledge on performance and testing of hydraulic turbines and pumps.
5. Prepare reports based on interpretation of experimental results.

Experiment Name

1. Calibration of V-notch
2. Calibration of rectangular notch
3. Calibration of Cippoletti notch
4. Calibration of Orifices
5. Calibration of mouthpieces
6. Calibration of venturi meter
7. Calibration of Orifice meter
8. Determination of friction factor of pipes
9. Experiment on Venturi flume
10. Experiment on standing wave flume
11. Calibration of broad crested weir
12. Calibration of curved weir
13. Impact of jet on vanes
14. Test on Centrifugal pump
15. Test on Pelton Turbine
16. Test on Francis Turbine
17. Demonstration of Kaplan Turbine
18. Demonstration of fluid pressure measurement using differential manometer and piezometer

Reference Books:

1. Modi P N and Seth S M, **Hydraulics and Fluid Mechanics**, Standard Book House.
2. Jain A K, **Fluid Mechanics**, Khanna Publishers.
3. Subramanya K, **Theory and Applications of Fluid Mechanics**, Tata McGraw Hill Publishing Co. Ltd, New Delhi.

CE 301A1 STRUCTURAL ANALYSIS-II [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. To apply the concept of strain energy to find the slope and deflection of beams and trusses.
2. To understand the mechanism of arches, cables and suspension bridges and analysis of these type of structures.
3. Description of various analysis approaches available for the analysis of Indeterminate structures and their application.
4. Analysis of Indeterminate beams.
5. Analysis of Indeterminate frames.

Module 1: Analysis of simple statically indeterminate beams by:

(a) Consistent deformation method
(b) Three-moment method.

[08]

Module 2: Analysis of Indeterminate beams and frames by:

(a) Slope deflection method: Degree of freedom, Fixed end moments, derivation of slope – deflection equation, slope-deflection equation for beams and frames, problems.
(b) Moment distribution method: Steps of moment distribution method, distribution factor at a pinned end and at a fixed end, problems.
(c) Kani's Method: Introduction, Application to indeterminate beams non-sway and sway portal frames**.**

[14]

Module 3: Analysis of Multistorey Frames by Approximate Methods

Introduction, Substitute frame method, Portal method, Cantilever method, Factor method, Problems.

[08]

Module 4: Unsymmetrical bending, shear center and Theories of Failures

Introduction, Principal moment of Inertia, Stresses in Beam due to Unsymmetrical Bending, Shear Centre.
Theories of Failures, Max Principal stress theory, Max strain theory, Max shear stress theory, Max strain energy theory, and Max distortion energy theory.

[08]

Module 5: Influence line diagram for determinate beams

ILD, Use of ILD, ILD for simply supported beams, cantilever beams and overhanging beams, Max SF and BM values due to moving loads.

[08]

Total Contact Hours – **46**

REFERENCE BOOKS:

Name of book	Author(s)	Publisher(s)
1. Structural Analysis-I	S.S.Bhavikatti	Vikas
2. Structural Analysis-II	S.S.Bhavikatti	Vikas
3. Elements of Strength of Materials	Timoshenko and Young	EWP
4. Theory of Structures	S. Ramamrutham	Dhanpat Rai P C
5. Structural Analysis	R.C. Hibbler	Pearson
6. Intermediate Structural Analysis	C.K. Wang	McGraw Hill

CE 302A1 ENGINEERING HYDROLOGY [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. To understand the concepts related to precipitation, it's data collection and analysis.
2. Utilize infiltration equations to compute infiltration rate, depth of infiltration and indices associated.
3. To identify factors affecting evaporation/transpiration and estimate the losses due to evaporation
4. To understand the processes associated with surface runoff to estimate runoff volume
5. To develop runoff hydrographs and recognize its significance in engineering practices

Module 1: Introduction and Precipitation

Definition and scope of the subject, world water resources, water resources of India, hydrologic cycle, hydrological data, hydrological equation.
Types of precipitation, rainfall intensity, duration and measurement, annual precipitation-depth, area, duration analysis, mean rainfall on a basin, isohyetal, Thiessen polygon, supplementing missing precipitation records, double mass curve analysis, moving average curve.

[07]

Module 2: Infiltration and Water Losses

Definition and factors affecting infiltration, infiltrometers, infiltration indices, infiltration equations, infiltration curves, determination of loss rates.
Evaporation and transpiration, factors affecting evaporation, measurement and estimation of evaporation, evaporation formulae, measure to reduce evaporation, transpiration process and factors affecting transpiration, evapotranspiration.

[08]

Module 3: Runoff and Hydrographs

Surface runoff process, types of catchments, catchments characteristics, factors affecting runoff, estimation of runoff, rainfall runoff correlations, use of multi-linear regression equation, stream gauging, mass flow curves and their uses.
Hydrographs and their characteristics, base flow separation, unit hydrographs, derivation of unit hydrograph, instantaneous unit hydrograph, S – hydrograph and its use, Snyder's synthetic unit hydrograph, uses of unit hydrograph.

[13]

Module 4: Flood Estimation and Routing

Rational Method, Empirical Formulae, Unit Hydrograph Method, Flood Frequency Method, Gumbel's Method, Log-Pearson Type III Distribution, Partial duration series, Regional Flood Frequency Analysis, Level pool routing, Attenuation, Hydrologic Channel routing, Hydraulic method of flood routing, Flood control in India

[07]

Module 5: Ground Water Hydrology

Forms of subsurface water, aquifer properties, equation of motion both confined and unconfined aquifers, steady flow into a well

[05]

Total contact hrs: **40**

Reference Books:

1. Vente Chow, **Applied Hydrology**, McGraw Hill
2. Mutreja, **Applied Hydrology**, McGraw Hill
3. Subramanya K, **Engineering Hydrology**, Tata McGraw Hill
4. Raghunath H M, **Hydrology**, Wiley New Delhi, Kanna Publishers
5. Nelson, Introduction to Copula, Springer

CE 306A1 HIGHWAY ENGINEERING – I [3 1 0 4]

Course Outcomes (CO):

After completion of this course, students should be able to

CO1	To understand the interactions between transportation planning and land use planning, economics, social planning and master plans.
CO2	To understand the principles and practices of transportation engineering and urban transportation planning.
CO3	Application of the basics of the geometric design of highways.
CO4	To develop knowledge about the different concepts of traffic engineering including traffic control, highway capacity, level of service etc.
CO5	To undertake various Traffic studies and apply the knowledge in planning and design of pavement and geometrics

Module 1: Introduction

Highway planning survey, location, soil surveys, highway economics and highway financing.

[07]

Module 2: Introduction to Transportation System Planning

Definition of trip generation, factors governing trip generation, purpose of trip distribution, different methods of trip distribution, uniform growth factor method, purpose of trip assignment, purpose of model split, factors affecting model split.

[08]

Module 3: Highway Geometric Design

Width, camber, gradient, sight distances, requirements of horizontal alignment – including radius of curvature, super elevation, curve resistance, grade compensation, transition curves and vertical curves.

[10]

Module 4: Traffic Engineering

Vehicular and road user characteristics, traffic studies – speed, speed delay, origin and destination, volume, traffic density, traffic capacity, relationship between speed, travel time, volume, density and capacity, passenger car units, traffic signs, traffic signals.

[08]

Module 5: Pavements

Factors which influence the design and selection of different types of pavements in detail, basic tests on aggregates and bitumen, CBR method, causes of failures of pavements, joints in concrete pavements.

[07]

Total contact hrs: **40**

Reference Books:

1. Khanna and Justo, **Highway Engineering**.
2. Hewes, **Highway Engineering**.
3. Sehgal and Bhanot, **A Text Book of Highway Engineering**.
4. Vazirani and Chandola, **Transportation Engineering Part I**
5. Kadiyali L R, **Traffic and Transportation Planning**.
6. Dr. Krishnamurthy, **Introduction to Bridges**.
7. Nayak B S, **A Book on Maintenance Engineering for Civil Engineers**.
8. Victor D J, **Essentials of Bridge Engineering**.

CE 307A1 PUBLIC HEALTH ENGINEERING [3 1 0 4]

Course Outcomes (CO):

After completion of this course, students should be able to

CO1	Design Water Supply Treatment Units with Different Flow Conditions
CO2	Apply concept of physical and chemical characteristics of water.
CO3	Understand the concept Different population forecasting Methods to predict future population.
CO4	Compute the different types of water Demand.
CO5	Analyse the distribution of water through pipe networks.

Module – 1: Introduction

Need for protected water supply, essentials of water supply, project documents preparation.
Population forecasting, different methods, rate of demand – factors affecting and its variation.

[06]

Module – 2: Sources of Water

Different sources of water, intakes, water borne diseases and their control, conveyance of water.
Physical, chemical and biological characteristics of Water, drinking water standards.

[08]

Module – 3: Treatment of Water

Aeration of water, types of aerators, theory of sedimentation, sedimentation with coagulation, coagulants, feeding devices, mixing devices, flocculation, design considerations.

[08]

Module – 4: Filtration

Types of filters – design considerations, disinfection theory, methods of disinfections, chlorination, other treatment methods, softening of water, removal of iron and manganese, defluorination.

[08]

Module – 5: Distribution of Water

Distribution methods, systems of supply, service reservoirs and their capacity, layouts of distribution. Pipe Appurtenances: Service connection, location of water supply pipes in buildings, wastage of water, leakage detection and prevention, corrosion and its prevention.

[10]

Total contact hrs: **40**

Reference Books:

1. **Manual on Water Supply and Treatment CPHEEO**, Ministry of Urban Development, New Delhi.
2. Garg S K**, Environmental Engineering**, Khanna Publishers Delhi.
3. Birdie G S, **Water supply and Sanitary Engineering**, Dhanpath Rai and Sons.

CE 301A4 COMPUTER AIDED STRUCTURAL ANALYSIS AND DESIGN
[0 0 2 1]

Introduction, Importance of the lab, Computer aided structural analysis and design software (STAAD, SAP, ETABS etc.)**.**

Experiment Title

1. Analysis of plane trusses.
2. Analysis and design of determinate beam.
3. Analysis of Indeterminate beam.
4. Analysis and design of non-sway plane frames.
5. Analysis of sway plane frames.
6. Analysis of space trusses.
7. Analysis of multistorey frames due to vertical loading (point load, self weight, dead load, live load etc.).
8. Analysis of multistorey frames due to wind load.
9. Seismic Analysis of multistorey frames.
10. Analysis and design of multistorey frames due to various load combination.

Reference:

1. STAAD Pro manual
2. SAP manual
3. ETABS manual
4. IS 875, IS 1893, IS 456, IS 800

CE 303A4 GEOTECHNICAL ENGG. LAB [0 0 2 1]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. To understand and apply the concept of soil mechanics to find the basic soil parameters like unit weight, water content, Atterberg's limit etc.
2. To identify the type of soil
3. To identify the and analyze the seepage characteristics
4. To evaluate the strength of the soil by finding cohesion and angle of internal friction
5. To evaluate the bearing capacity of the soil.

Experiment Title

1. Determination of natural moisture content.
2. Determination of specific gravity
3. Determination of Atterberg's limits.
4. Determination of in-situ unit weight by
   (a) sand replacement method
   (b) core cutter method.
5. Determination of coefficient of permeability by
   (a) Constant head permeameter
   (b) Variable head permeameter.
6. Compaction test – Standard and modified compaction tests, use of Proctor needle.
7. Determination of shear strength characteristics by
   (a) Direct shear test
   (b) Unconfined compression test
   (c) Triaxial test (no pore pressure and volume change measurement)
   (d) Vane shear apparatus
8. Field Tests – Demonstration of the following tests:
   (a) Cone penetration tests
   (b) CBR tests

References:

1. IS: 2720 Part II, 1973, Soil test, determination of Water Content
2. IS: 2720 Part III sec: I, 1980, Soil test, determination of Specific Gravity.
3. IS: 2720 Part XXIX, 1975, Soil test, determination of dry density of soils in place by the core cutter.
4. IS: 2720 part IV, 1965, method of test for soil, grain size analysis.
5. IS: 2720 part V, 1965, determination of liquid and plastic limits
6. IS: 2720 part VI, 1964, determination of shrinkage factors
7. IS: 2720, part XXVIII, 1966, determination of dry density of soil in place by sand replacement method.
8. IS: 2720, part VII, 1965, determination of dry density by using light compaction
9. IS: 2720 part XVII, 1966, soil test, laboratory determination of permeability

10. IS: 2720 part XI, 1971, soil test, determination of shear strength
11. IS: 2720 part XIII, 1972, soil test, direct shear test
12. IS: 2720, part XXXIX, sec. I, 1977, soil test, direct shear test.
13. IS: 2720 part X, 1973, soil test, determination of unconfined compression
14. IS: 2720 part XVI 1965, Laboratory determination of CBR
15. Bowles J E, Engineering Properties of Soil and their Measurement, McGraw Hill
16. Lambe T W, Soil Testing for Engineers, John Wiley and Sons
17. Cheng Liu and Jack B Evett, Soil Properties, Testing, Measurements and Evaluation, Prentice Hall New Jersey.

GN301A1 QUANTITATIVE APTITUDE AND LOGICAL REASONING – I
[1 0 0 1]

Questions to be set: 05 (All Compulsory)

Course Objective: The main aim of introducing "Quantitative Aptitude & Logical Reasoning" to university students is to develop numerical skills among students and to prepare them for various examinations to enhance better job prospects. This initiative is being taken to include essential mathematical principles to build students' confidence. It is expected to expand students' knowledge and foster their logical reasoning and analytical thinking abilities.

Pre-requisites: NIL

Course Outcomes (CO): On successful completion of the course

CO	STATEMENT
CO1	Student will be able to solve variety of simple problems in the space of quantitative domain.
CO2	Students will be able to use data to determine or to deduce other facts from a set of given data of less complexity.
CO3	Students will be able to use shortcuts, tricks and techniques to solve the problems with moderate accuracy.
CO4	Students will be able to demonstrate essential skills pertaining to public speaking, resume writing and telephone etiquette.
CO5	Students will be able to demonstrate basic skills during the placement interviews

Module	Topics	Hrs.	CO	PO	PSO
Module 1: **Quantitative Aptitude**	Problems on Trains, Time and Distance, Height and Distance, Time and Work, Simple Interest, Compound Interest, Profit and Loss, Partnership, Percentage, Problems on Ages, Calendar, Clocks, Average, Area, Volume and Surface Area	6	1		
Module 2: **Puzzles, Problem Solving and Analysis**	Sudoku, Number Puzzles, Missing Letter Puzzles, Playing Card Puzzles, Clock Puzzles.	3	2		
Module 3: **Logical Reasoning**	Number Series, Letter and Symbol series, Verbal Classification Essential Part, odd man out and visual reasoning, Analogies, Artificial Language, Matching Definitions, Making Judgements.	5	3		
Module 4: **Professional Builder**	Resume Writing, Public Speaking, Extempore, Telephone etiquette.	4	4		
Module 5: **Use Cases**	Mock Interview – Hard and Soft Skills Sector: FMCG, IT, Production, Manufacturing etc.	2	5		

Textbooks:

1. Aggarwal, R. S. (2008). *Quantitative Aptitude*. S. Chand., ISBN: 9788121924986, 8121924987
2. Devi, S. (2005). *Puzzles to puzzle you*. Orient Paperbacks., ISBN: 8122200141, 9788122200140

CE 305A1 CONSTRUCTION PLANNING AND MANAGEMENT
[2 0 0 2]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Understand various stages of construction planning and scheduling
2. Apply the network analysis in a project plan
3. Analyse a project plan using PERT and CPM.
4. Evaluate the relationship of project cost with the scheduling and updating.
5. Identify the advancements in concreting equipment and techniques.

Module – 1: Introduction

Management - Characteristics, Purpose, Different level Management, Roles and Skills. Project, Project management, Project life cycle, Introduction to Construction management- Classification of construction works, Requirement of Construction Industry, Characteristics, Importance, Necessity, Objective, Function, Various Construction Stages, Construction Team.

[04]

Module – 2: Function of Construction Management and Project Updating

Construction Planning: Principles of planning, Objectives, Stages of planning by different agencies. Data required for updating, updating flow chart, Target delivery date, Process and progress report on project updating.

[04]

Module – 3: Network Analysis

Introduction, Definition, Terminology, Classification of network, Fulkerson's rule for numbering the events. Network logic, Difference between AOA and AON diagram, Common error in drawing network, Scheduling- Gantt or Bar charts, milestone charts, Network analysis- Objective, Procedure and advantage of network technique, CPM and PERT, Work breakdown structure.

[08]

Module – 4: Project scheduling and Resource levelling:

Introduction, Resource levelling and allocation, importance of project schedule and other project schedule details. Network crashing and cost-time trade off

[04]

Module – 5: Management of Construction Equipment's

Classification of construction equipment: Earthwork equipment and Concreting equipment, factor affecting selection of construction equipment's, Plant and equipment acquisition.

[04]

Total contact hours: **24**

Reference Books

1. Neeraj Kumar Jha, **Construction Project Management,** Theory and Practice, PEARSON.
2. KK Chitkara, **Construction Project Management**, Planning Scheduling and Controlling, McGraw Hill Education (INDIA).
3. S Seetharam, **Construction Engineering and Management**, Umesh Publication, Delhi
4. B Sengupta and H Guha, **Construction Management and Planning**, Tata McGraw Hill Companies.
5. BC Punmia, and KK Khandelwal, **Project Planning and Control with PERT and CPM,** Laxmi Publication.

CE 308A1 DESIGN OF STEEL STRUCTURES
[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):
After completion of this course, students should be able to

1. Interpret the various properties of the structural steel and classification of the steel.
2. Explain the Concept of limit state method and working stress method for design of steel structures.
3. Apply the concept of limit state method to analyze and design of tension members in real time problems.
4. Analyze and design of compression members using the concept of limit state method.
5. Utilize the concept of limit state method to analyze and design of flexural members (Beams and plate girders)

Module 1: Introduction and Connections
Composition and general behavior of steel, importance of steel construction, structural shape and arrangements, design philosophy (WSM and LSM), Factor of Safety, Permissible and Working Stresses. Specifications and strength of simple riveted connection, bolted connection and welded connection to transfer axial forces. (LSM)

[12]

Module 2: Tension Members
Types of tension members, permissible stresses, net sectional area, design of a tension member using welds and bolts. (LSM)

[08]

Module 3: Compression Members
Shapes of compression members, design of axially loaded compression members, built-up columns and lacing. (LSM)

[08]

Module 4: Beams
Types of sections, lateral stability of beams, bending stress, bearing stress, shear stress, deflection, web buckling, web crippling, diagonal buckling, design of laterally supported beams, built-up beams (plated beams), laterally unsupported beams (only welded connection is considered). (LSM)

[08]

Module 5: Welded Plate Girders
Types of sections, elements of plate girder, proportioning of web, proportioning of flanges, self-weight of plate girders, curtailment of flange plates, connections, stiffeners - detailed design. (LSM)

[08]

Total contact hrs: **44**

Reference Books:

1. Negi L S, **Design of Steel Structures.**
2. Duggal S K, **Design of Steel Structures.**
3. Arya A S and Ajmani J C, **Design of Steel Structures.**
4. Dayarathnam P, **Design of Steel Structures.**
5. Ramachandra, **Design of Steel Structures.**
6. N Subramanian, **Design of Steel Structures**
7. S P 6(1) – 1966 Structural Steel Sections.
8. IS 800 – 1984. Code of practice for General Construction in Steel
9. IS 800 – 2007 Code of practice for General Construction in Steel
10. Steel notes in website www.Insdag.org.

CE 309A1 ESTIMATING, COSTING AND VALUATION
[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Determine the earthwork calculation for roads and canals.
2. Understand preparation of Notice inviting tender document for bidding, tendering process and examining rate analysis of civil works.
3. Evaluate the valuation of buildings for different specifications and create new technologies to develop concrete estimating methods.
4. Analyze the rates of various civil engineering items used in construction.
5. Prepare the estimate of various kinds of buildings with skill lasting for entire professional life.

Module – 1: Earth Work Calculation
Measurement of earth work by cross sections, spot levels, contours, mass diagram and its characteristics.

[06]

Module – 2: Specifications and Rate Analysis
Definition, types, principles, detailed specification for different components of buildings. Purpose, factors affecting rate analysis, overhead charges, turn-out of work, rate analysis for different items of building.

[08]

Module – 3: Departmental Procedure
Functioning and organization of PWD, tender and its notification, EMD and security deposit, qualification of contractor, responsibilities of engineer, owner, contractor, different methods of execution of work, measurement book, nominal muster roll, running bill, agreement, schedule rate, contract: - types of contracts, termination of contract, work slip, arbitration.

[09]

Module – 4: Valuation
Purpose of valuation, different methods of valuation (open land and land with buildings), valuation of properties, types of rent, rent fixation, depreciation – different methods, book value, market value, scrap and salvage value, time value of money, interest factors, amortization, deferred payments.

[08]

Module – 5: Estimation
Definition, types of estimates, units of measurement, method of estimation, project contingencies, work charged establishment, plinth area, carpet area, estimation for buildings, R.C.C. works, roads, irrigation works, different types of roofs.

[09]

Total contact hours: **40**

Taking out quantities and preparing abstract of estimated cost for:

1. Residential load bearing structure (use both centerline and long-wall short-wall method)
2. Office building – framed structure.
3. Slab, culvert, water tank.
4. Waste weir
5. Earth work calculation for roads, reservoirs.

Reference Books:

1. Dutta B N, **Estimating and Costing in Civil Engineering**.
2. Chakraborti M, **Estimating and Costing in Civil Engineering**.
3. Birdie, **Estimating and Costing in Civil Engineering**.
4. CPWD Manual for Standard Specification and Rate Analysis.
5. PWD Sikkim Schedule of Rates.
6. Roshan H Nanavati, **Professional Practice**.

CE 302A4 ENVIRONMENTAL ENGINEERING LAB [0 0 2 1]

Course Outcomes (CO):
After completion of this course, students should be able to

1. To compute total solids, suspended solids, dissolved solids, volatile and fixed solids both water and wastewater
2. To understand the concept of physical characteristics of water and wastewater.
3. To understand the safe disposal of wastewater.
4. To compute chemical characteristics of water and wastewater.
5. To evaluate physical properties of filter sand.

Experiment Title

1. Determination of solids: Total solids, suspended solids, dissolved solids, volatile solids, fixed solids, settleable solids.

2. Determination of Alkalinity, Acidity and pH.

3. Determination of Calcium, Magnesium and total Hardness.

4. Determination of Chlorides.

5. Determination of Dissolved Oxygen.

6. Determination of Residual Chlorine and chlorine demand.

7. Determination of percentage available chlorine in Bleaching powder.

8. Determination of B.O.D.

9. Total count test and MPN determination.

10. Filter sand analysis – Effective size and uniformity coefficient.

Reference Books

1. **Standard methods for the examination of Water and Wastewater**, ALPHA – AWWA - WPCF
2. Sawyer and McCarty, **Chemistry for Environmental Engineering**.
3. **IS: 3025 -1964, Methods of sampling and test** (physical and chemical) for water used in Industry.
4. S K Hussain, **A Textbook of Water Supply and Sanitary Engineering**.
5. **Methods for Chemical Analysis of Water and wastes** – 1974 U.S. EPA Technology transfer 625/6-75003 pp. 266 – 267.
6. G S Birdie, **Environmental Engineering.**
7. **Drinking Water Standards**, IS: 10500 – 1983.

CE 304A4 GEOINFORMATICS LAB [0 0 2 1]

Course Outcomes (CO):

After completion of this course, students should be able to

1. Acquiring practical knowledge and hands-on experience in remote sensing technique.
2. Learning various GIS operations for creation, analysis and interpretation of thematic maps
3. Applying various digital image processing techniques to extract hidden features and information
4. Classifying digital satellite images using supervised and unsupervised classification techniques
5. Performing analysis and modelling through integration of remote sensing and GIS

Experiment Title

Digital Image Processing

Practical 1: Computation of spatial statistics on 2-D matrices
Practical 2: Import, format conversion and display of images
Practical 3: Geometric correction and image to image registration
Practical 4: False Colour Composites (FCC) and filtering operations
Practical 5: Image space and feature space conversion, sampling concepts
Practical 4: Unsupervised classification on an image
Practical 5: Supervised classification on an image
Practical 6: Error Matrix Calculation

Geographic Information Systems

Practical 1: Data joining, query analysis
Practical 2: Digitisation: point, line, area
Practical 3: Geoprocessing tools (Conversion of coordinates and projections)
Practical 4: Spatial analysis tools (Interpolation)
Practical 5: Network analysis, shortest path, location-allocation
Practical 6: Overlay analysis exercise
Practical 7: AHP exercise with sample data
Practical 8: Case study with sample GIS database

Reference Books:

1. John R Jenson, Introductory Digital Image Processing, Prentice Hall.
2. Burrough P A, Principles of Geographical Information System for Land Resource Assessment, OxfordUniversity Press.
3. Bonham-Carter G F, Geographic information systems for geoscientists modelling with GIS (1995) Pergamon.
4. ESRI User Manual.

GN302A1 QUANTITATIVE APTITUDE AND LOGICAL REASONING - II
[1 0 0 1]

Questions to be set: 05 (All Compulsory)

Course Objective:
The key objective of this course is to strengthen the numerical skills and logical abilities & skills of university students and prepare them for various competitive exams, thereby improving their employment opportunities. This initiative aims to incorporate fundamental mathematical principles to build students' confidence. Additionally, it seeks to broaden their knowledge and foster their logical reasoning and analytical thinking skills.
Pre-requisites: NIL

Course Outcomes (CO): On successful completion of the course

CO	STATEMENT
CO1	Student will be able to solve variety of problems simple to complex in the space of quantitative domain.
CO2	Students will be able to use data to determine or to deduce other facts from a set of given data which are simple to complex.
CO3	Students will be able to use shortcuts, tricks and techniques to solve the problems with high accuracy.
CO4	Students will be able to demonstrate essential skills pertaining to business communications.
CO5	Students will be able to demonstrate advanced skills required at the time of placement interviews.

Module	Topics	Hrs.	CO	PO	PSO
Module 1: **Quantitative Aptitude**	Problems on Permutations and Combinations, Probability, Numbers, Problems on Numbers, Problems on HCF and LCM, Decimal Fraction, Simplification, Square Root and Cube Root, Surds and Indices, Ratio and Proportion, Chain Rule, Pipes and Cistern, Boats and Streams, Allegation and Mixtures, Logarithm, Races and Games, Stocks and Shares, Probability, True Discount, Odd man out and Series.	8	1		
Module 2: **Puzzles, Problem Solving and Analysis**	Logical Connectives and Syllogisms, Data Interpretation, Cases, Venn Diagrams.	3	2		

Module 3: **Logical Reasoning**	Verbal Reasoning, Logical Problems, Logical Games, Data Arrangement and Blood Relations, Analyzing Arguments, Statement and Assumption, Course of action, Statement and Conclusion, Theme Detection, Cause and Effect, Statement and Argument, Logical Deduction.	4	3		
Module 4: **Professional Builder**	CV Writing, Verbal & Non-Verbal Communication, Group Discussion, Netiquettes,	2	4		
Module 5: **Use Cases**	Mock Interview on Hard and Soft Skills Sector - IT, FMCG, Product, Financials, Manufacturing, Production, Construction etc.	3	5		

Textbooks:

1. Aggarwal, R. S. (2008). *Quantitative Aptitude*. S. Chand., ISBN: 9788121924986, 8121924987

2. Devi, S. (2005). *Puzzles to puzzle you*. Orient Paperbacks., ISBN: 8122200141, 9788122200140

CE 302A5 MINI PROJECT [0 0 4 2]

Serial No	Subject	Objective	Total Credit
1	Mini Project	The students are required to undertake innovative and research-oriented projects under the direct supervision of a faculty member of the department. The Mini Project should not only reflect their knowledge gained in the previous semesters but also acquire additional knowledge and skills by their own effort. The Mini Projects are assigned at the end of 5th Semester and the final evaluation is carried out at the end of 6th Semester.	02
2	Mini Project Review	The progress of the project will be evaluated in phases through interim seminars/ presentations.	
3	Evaluation	The faculty/ guide will assess the Mini Project	

CE 401A6 MAJOR PROJECT Phase - I [0 0 14 7]

Serial No	Subject	Objective	Total Credit
1	Major Project	The students are required to undertake innovative and research-oriented projects under the direct supervision of a faculty member of the department. The Major Project should not only reflect their knowledge gained in the previous semesters but also acquire additional knowledge and skills by their own effort. The Major Projects are assigned at the end of 6th Semester (based on their Mini Project) and the final evaluation is carried out at the end of 8th Semester.	07
2	Major Project Review	The progress of the project will be evaluated in phases through interim seminars/ presentations.	
3	Evaluation	The project will be evaluated by a panel of faculty members of the parent department as well as of another department of the institute.	

CE 402A6 MAJOR PROJECT Phase II [0 0 24 12]

Serial No	Subject	Objective	Total Credit
1	Major Project	The students are required to undertake innovative and research-oriented projects under the direct supervision of a faculty member of the department. The Major Project should not only to reflect their knowledge gained in the previous semesters but also to acquire additional knowledge and skills by their own effort. The Major Projects are assigned at the end of 6th Semester (based on their Mini Project) and the final evaluation is carried out at the end of 8th Semester.	12
2	Major Project Review	The progress of the project will be evaluated in phases through interim seminars/ presentations.	
3	Evaluation	The project will be evaluated by a panel of faculty members of the parent department as well as of another department of the institute.	

CE 301A9 INDUSTRIAL TRAINING I [0 0 2 1]

The students are required to undergo training in Civil Engineering industries or Design Farms for **two weeks** after 4th Semester during the Summer Vacation. After returning from the Industrial Training, the students must submit a detailed report of the training and give a seminar/ presentation.

Members of the Departmental Training and Placement Cell will evaluate, and award marks based on the report and the presentation.

Industrial Training may be carried out by students in groups; however, they need to submit report and give presentation separately.

CE 401A9 INDUSTRIAL TRAINING II [0 0 2 1]

The students are required to undergo training in Civil Engineering industries or Design Farms for **four weeks** after 6th Semester during the Summer Vacation. After returning from the Industrial Training, the students must submit a detail report of the training and give seminar/ presentation.

Members of the Departmental Training and Placement Cell will evaluate, and award marks based on the report and the presentation.

Industrial Training may be carried out by students in groups; however, they need to submit report and give presentation separately.

Alternatively, students can be encouraged to learn programing languages like C, C++, Python or advanced macro and VB script in Excel. NPTEL or Udemy course can be used.

PROGRAM ELECTIVES

List of Program Electives

Subject Code	Program Elective-I (3rd Semester)	Subject Code	Program Elective-IV (6th Semester)
CE201A3	Surveying	CE306A3	Geoinformatics
CE202A3	Latest Trends in Civil Engineering	CE307A3	Advanced Structural Analysis
		CE308A3	Structural Dynamics and Earthquake Engineering
	Program Elective-II (4th Semester)		**Program Elective-V (6th Semester)**
CE204A3	Irrigation Engineering	CE311A3	Waste Water Engineering
CE206A3	Advanced Concrete Technology	CE312A3	Railways, Airports, and Tunneling Engineering
		CE313A3	Bridge Engineering
		CE314A3	Advanced Foundation Engineering
	Program Elective-III (5th Semester)		
CE301A3	Advanced Geotechnical Engineering		
CE302A3	Advanced Design of RC Structures		
CE304A3	Ground Water Engineering		

Prof. (Dr.) Chandrashekhar Bhuiyan
(Professor & Head)

Mr. Sajal Sarkar
(Assistant Professor –SG)

Mr. Guru Prasad Sharma
(Assistant Professor –SG)

PROGRAM ELECTIVE I
(SEMESTER III)

CE 201A3 SURVEYING [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Remembering the basics principles of different methods of plane surveying.
2. Understand the idea and concept of various methods of surveying.
3. Applying the techniques of modern tools to find the measurements in horizontal and vertical plane
4. Understanding the various way to collect data from field in plane table surveying
5. Analysing the field data to calculate the Reduced level of any point on ground.

Module 1:
Introduction

Principle of surveying, methods, plane and geodetic, principles of chain surveying – chain and tape survey of a field. Maps - scale, coordinate system, Principles, use and adjustment of prismatic compass and surveyors compass, bearings and included angles, declination, local attraction, plotting of open and closed traverses

[06]

Module 2:
Leveling

Terms and definitions, differential leveling, checking of levels, reducing errors and mistakes in leveling, collimation correction, curvature and refraction, profile leveling, cross sections, reciprocal leveling, contouring - applications and uses

[10]

Module 3:
Tachometry

Measurement of horizontal and vertical angles, height and distance formulae, theodolite traverse, electronic theodolite. Principles, methods – analytic tacheometer, distance and elevation formulae for horizontal and inclined site with staff vertical and normal.

[08]

Module 4:
Curves

Introduction, simple curve, basic definition, compound curve, reverse curve, transition curve, lemniscate curve, vertical curve, design of vertical curve.

[09]

Module 5:
Photogrammetric Survey

(a) Terrestrial: principles, photo-theodolite, horizontal and vertical distances of points from photographic measurements.
(b: Aerial camera, scale of vertical photograph, drag and lift computation of flight plane.
[07]

Total contact hours: 40

Reference Books:

5. Kanetkar T P and Kulkarni S V, **Surveying and Levelling Part I & II** , Pune Vidyarthi Griha Prakashana, Pune.
6. Devid Clark, **Plane and Geodetic Surveying for Engineers, Vol I & II,** CBS Publication
7. Norman Thomas, **Surveying,** Edward Arnold Publishers (ELBS) London.
8. Arora K R, **Surveying Vol. I & II**, Standard Book House New Delhi
9. Punmia B.C, **Surveying Vol. I & II,** Lakshmi Publications, New Delhi
10. NN Basak, surveying and Levelling, Paperback

(SEMESTER III)

CE 202A3 LATEST TRENDS IN CIVIL ENGINEERING

[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):
After completion of this course, students should be able to

1. To gain knowledge about the latest machineries, techniques and structures.
2. To understand environment impact assessment and effect of pollution.
3. To learn the technique for identification and analysis of drought and flood
4. To understand the technicalities involved in creating high performance concrete.
5. To identify the most suitable technique for ground improvement for a particular type of soil

Module 1: *Emerging trends* in ground improvement

Need for Ground Improvement, Classification of ground modification techniques, *Emerging trends* in ground improvement.

[06]

Module 2: Recent improvements in concrete

Fiber reinforced concrete, High strength concrete, Self-compacting concrete, Testing self-compacting concrete, Concreting in cold weather, Concreting in hot weather.

[06]

Module 3: Building information modeling (BIM)

Introduction, BIM in Construction Management, Interpretation of BIM, Benefits of BIM, Virtual Prototyping of Models, Collaboration and Information Management, Potential of BIM enabled Models.

[06]

Module 4: Current Trends in Water Resources

Extreme hydrology, Flood and drought, Rain water harvesting, Artificial ground recharge, Flood reduction modeling.

[06]

Module 5: Modern construction practices

Modern construction equipment, Prefabricated structure, Ready mix concrete**,** modern methods of construction, composite construction.

[06]

Module 6: Recent trends in environmental engineering

Environmental impact assessment, Environmental management, Air pollution, Solid and hazardous waste management.

[06]

Total contact hours: **40**

PROGRAM ELECTIVE II
(SEMESTER IV)

CE 204A3 IRRIGATION ENGINEERING [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):
After completion of this course, students should be able to

1. To remember various aspects of distribution of water in a irrigation system
2. To understand the governing factors for water requirements of crops.
3. To apply different theorems to find out sediment transport.
4. To analyze different factors for reservoir site selection without affecting the surrounding environment.
5. To understand the basic components of river training works.

Module 1:
Introduction
Definition, necessity, benefits and ill-effects of irrigation, classification of irrigation projects, types of irrigation systems, their merits and demerits, methods of distribution of water, comparative study of these methods, need for planned utilization of water resources.

[05]

Module 2:
Water Requirements of Crops
Introduction, functions, factors affecting, quality of irrigation water, main crops and their seasons, consumptive use of crops and irrigation requirements, irrigation efficiencies, duty, delta, base period, relationship among them, related terms, estimation of design discharges, storage capacities, factors affecting duty and measures to improve duty, soil moisture contents, depth and frequency of irrigation, assessment of irrigation water charges.

[08]

Module 3:
Sediment Transport and Design of Irrigation Channels
Importance of sediment transport, sediment load, bed formation, mechanics of sediment transport, shield's diagram, regime channel.

[05]

Module 4:
Water Logging, Salinity and Rivers, Their Behaviour, Control and Training
Definition of salinity and water logging, causes of water logging, water logging control, leaching, open drainage, tile drainage and reclamation of saline lands. Importance of rivers

and necessity of controlling them, types of rivers and their characteristics, classifications of rivers, behaviour of rivers, control and training of rivers, methods of river training.

[12]

Module 5:
Gravity dams, Spillways and Earth dams

Non-overflow section, forces acting on gravity dams, design of gravity dams by step method, introduction to other methods like trail load, finite element, slab analogy etc., stresses in dams, stress concentration in openings of dams, design of sluices, air vents and galleries, Types of spillways, design of spillways, energy dissipators, gates, types of hoists. Investigations, design of cross section of dams, slope stability analysis, settlement analysis.

[10]

Total contact hrs: **40**

Reference Books:

1. Punmia B C, and Pande B B, **Irrigation and Water Power Engineering**, Standard Publishers, New Delhi.
2. Sharma R K, **Irrigation Engineering and Hydraulic Structures**, Oxford and IBH
3. Garg S K, **Irrigation Engineering and Hydraulic Structures**, Khanna Publishers.
4. Modi P N, **Irrigation, Water Resources and Water Power Engineering**.
5. Priyani V B, **Fundamental Principles of Irrigation and Water Power**, Chartor Book Stall, Tulasi Sadan, Station Road, Anand
6. MichealA M, **Irrigation Theory and Practice**, Vikas Publishers, N. Delhi.
7. Singh Bharath, Nemchand and Bros, Roorkee, **Fundamental of Irrigation Engineering.**
8. Cregar, **Engineering of Dams Vol I, II and III**, Justin and Hinds-Wiley Elsevier, N Delhi
9. Houk John Wiley New York, **Irrigation Engineering Vol I & II**
10. Sharma K R, Sri Sunder Das, **Irrigation Engineering Vol I & II,** Noble Book Service New Rajendra Nagar New Delhi.
11. Arora K R, Irrigation**, Water Power and Water Resources Engineering**

(SEMESTER IV)

CE206A3 ADVANCED CONCRETE TECHNOLOGY
[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

1. To learn about various types and composition of cement.
2. To study various types and use of admixtures.
3. To learn about Mix design, and high strength concrete.
4. To study crucial properties like creep and shrinkage of concrete.
5. To learn about durability and performance of concrete.

Module 1: Cement production, Cement classification and composition Cement chemistry, Aggregates for concrete

[08]

Module 2: Chemical admixtures and Mineral admixtures

[08]

Module 3: High performance concrete Mixture proportioning, Topics in Fresh concrete, Fresh properties, Topics in hardened concrete, Introduction to Harden concrete properties, Post peak response and Fibre reinforced concrete.

[09]

Module 4: Creep and shrinkage Shrinkage: Mechanism and Behaviours, Creep: Mechanism and Behaviours, Shrinkage: Plastic Shrinkage, Shrinkage: Drying Shrinkage

[08]

Module 5: Durability of concrete Durability of concrete Introduction to Durability, Performance based specifications for durable concrete, Durability issues in concrete

[09]

Total: 40 Hours

References:

1. Advanced Concrete Technology, by Prof. Manu Santhanam https://nptel.ac.in/courses/105106176
2. Concrete Technology: Theory and Practice by M. S. Shetty
3. Concrete Technology by Adam M. Neville and J. J. Brooks
4. Concrete Technology by Murari Lal Gambhir
5. Advanced Concrete Technology 1*:* Constituent Materials by *John Newman, Ban Seng Choo*
6. Advanced Concrete Technology by Zongjin Li
7. Durability of Concrete: Design and Construction by Arnon Bentur, Mark G. Alexander, and Sidney Mindess
8. Advanced Concrete Technology by Dr. S. Kandasamy)
9. IS 10262: 2019, Concrete Mix Proportioning — Guidelines

PROGRAM ELECTIVE III
(SEMESTER V)

CE 301A3 ADVANCED GEOTECHNICAL ENGINEERING
[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):
After completion of this course, students should be able to

1. To understand and apply the concept of Stability of slopes and forces acting on the retaining wall.
2. To apply the shear strength parameters and finally find the bearing capacity of a soil in order to do foundation design.
3. To evaluate the load carrying capacity of a particular footing or foundation.
4. To apply ground improvement techniques in order to improve the strength and bearing capacity.
5. The students will be able to investigate the soil and identify its properties for evaluation of its load carrying capacity.

Module – 1:

Shear Strength of Soils

Concept of shear strength of soils, Mohr-Coulomb theory and failure criteria, Mohr's Circle, laboratory determination of shear strength parameters – direct shear, tri-axial, unconfined compression and vane shear tests, limitations of test results.

[07]

Module – 2:

Soil Exploration and Stability of Slopes

Objective, methods of boring, requirements of good sampler, types of samples, sampler tubes, significant depth, depth and spacing of bore holes, penetration tests, exploration log, planning of exploration programme, Content of Geotechnical investigation report.

Finite and infinite slopes, types of failure of finite slopes, method of slice and friction circle, effect of sudden draw down and submergence.

[09]

Module – 3:

Earth Pressure

Rankine and Coulomb's theories for active and passive condition, Bell's equation for C-F soil, earth pressure at rest - factors influencing earth pressure like surcharge, water table and wall friction.

[07]

Module – 4:

Bearing Capacity of Shallow Footings

Tezaghi's theory (no derivation), modes of shear failure, factors affecting bearing capacity, allowable bearing pressure IS recommendations – permissible, total and differential settlement, estimation of bearing capacity from plate load and penetration tests.

[08]

Module – 5:

Pile Foundation and Well Foundation

Pile driving, bearing capacity of a single pile in clay and sand – Engineering News and Hiley's formulae, IS pile load test, group action and negative skin friction.

Components of well foundation, depth of well as per IRC, sinking of wells, tilts and shifts.

[09]

Total contact hours: **40**

Reference Books:

1. Arora K R, **Soil Mechanics and Foundation Engineering**, Standard Publishers
2. Gopal Ranjan and Rao A S R, **Basic and Applied Soil Mechanics**, New Age International
3. Punmia B C, **Soil Mechanics and Foundations**, Laxmi Publications
4. Murthy V N S, **A Textbook of Soil Mechanics and Foundation Engineering**, Sai Kripa Technical Consultant, Bangalore
5. Bowels J E, **Foundation Analysis and Design**, McGraw Hills Book Company
6. Srinivaslu and Vaidyanathan, **Handbook of Soil Mechanics and Foundation Engineering**, Tata McGraw Hill Book Company.
7. Ramiah B K and Chickanagappa L S, **Handbook of Soli Mechanics and Foundation Engineering**, Oxford and IBH.
8. Hsai – Yang Fang, **Foundation Engineering Handbook**, CBS Publishers

(SEMESTER V)

CE 302A3 ADVANCED DESIGN OF RC STRUCTURES
[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Apply the direct design method to design the Flat Slab.
2. Understanding the basic concepts of design for slender column.
3. Apply the concept of limit state method to analyze and design of various types of staircases.
4. Analyze and design of footings using the concept of limit state method.
5. Utilize the concept of limit state method to analyze and design of retaining wall and water tank.

Module 1: Design of Flat slab
Interior panels - direct design method [06]

Module 2: Design of column and footing
Design of eccentric short column, Design of Slender column, design of combined footings. [11]

Module 3: Staircases
Types of stairs, design of dog legged staircase. [08]

Module 4: Retaining walls
Types of retaining walls, design of cantilever retaining walls. [08]

Module 5: Water tanks
Design of water tanks as per IS: code 3370, rectangular and circular tanks resting on ground. [07]

Total Contact hours: **40**

Reference Books:

1 Shah H J, **Reinforced Concrete Vol.I,**Charotar .
2 Sinha N.C and Roy S.K, **Fundamentals of Reinforced Concrete**, S Chand.
3 Shah N L and Karve S R, **Illustrated Reinforced Concrete Design**,
4 Karve S R and Shah **Limit state Theory and Design of Reinforced Concrete**.
5 Jain A K **Reinforced Concrete – Limit State Design**.
6. Mallick& Gupta **Reinforced concrete Design**
7. P.C. Varghese **Limit State Design of Reinforced Concrete**
8. Pillai and Menon **Reinforced Concrete Design**, Tata McGraw Hill

(SEMESTER V)

CE 304A3 GROUNDWATER ENGINEERING
[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):
After completion of this course, students should be able to

1. Interpret the various characteristics of aquifers and their significance.
2. Explain the Concept of confined and unconfined aquifers related to groundwater flow problems.
3. Apply the concept of Darcy law to compute the yield from different aquifers.
4. Analyze and design of confined and unconfined wells using well hydraulics.
5. Description of various methods on the process and techniques of natural and artificial recharge of groundwater.

Module – 1: Introduction and Fundamentals of Groundwater Flow

Definition of ground water, hydrological classification of geological formations, aquifers and their types, subsurface zones and water-table, springs: occurrence, flow and storage of groundwater in igneous, sedimentary and metamorphic rocks, geological zones in India. Fundamentals of groundwater Flow Darcy's law and range of its validity, oil anisotropy, circulation of groundwater in isotropic and anisotropic media, groundwater flow in fractured rocks, parallel plate model, double porosity model, equivalent porous medium model, discrete fracture network model, and equivalent parallel plate model, groundwater flow in confined and unconfined aquifers, Dupuit's assumptions, principles and mechanics of solute transport, advection, dispersion, molecular diffusion, retardation.

[10]

Module – 2: Mechanics of Well Flow

Water table contour map and flow net analysis, groundwater flow problems, steady uniform flow, steady radial flow to a well, a well in a uniform flow, aquifer parameters, introduction to unsteady flow in aquifers, pump tests, radial flow to a well in an extensive confined aquifer, barrier and recharge boundaries, image well, introduction to unsteady radial flow.

[09]

Module – 3: Exploration of Groundwater

Surface and subsurface methods for well-site selection, field investigation, remote sensing and GIS applications, geophysical methods, tracer tests.

[08]

Module – 4: Well Development and Management

Well-design criteria, size and spacing of wells, diameter of wells, well characteristics, well efficiency, construction and maintenance, screens and casings., dug well versus tube well construction.

[05]

Module – 5: Groundwater Recharge

Water level fluctuation and rainfall infiltration factor method, traditional methods of groundwater conservation, artificial recharge of groundwater, planning and site selection, various methods and structures such as rainwater harvesting, stream augmentation, bank filtration, recharge wells, ditch and furrow, well injection, aquifer storage and recovery, groundwater basin management and conjunctive use.

[08]

Total contact hours: 40

Reference Books:

1. Todd D K, **Groundwater Engineering**.
2. Walton W C, **Groundwater Resources**, McGraw Hill
3. Sharma and Chawla, **Manual of Groundwater and Tube**, C.B.I.P wells.
4. De Weist R J M, **Geo-hydrology**, John Wiley.
5. Bouwer H, **Groundwater Hydrology**, McGraw Hill
6. Raghunath H M, **Groundwater,** Wiley Eastern Ltd.

PROGRAM ELECTIVE IV
(SEMESTER VI)

CE 306A3 GEOINFORMATICS [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

CO1: Remembering the basic principles of Aerial Photography and Satellite Remote Sensing
CO2: Understanding the physics and fundamental concepts of Remote Sensing
CO3: Applying the techniques of digital image processing for feature extraction and mapping
CO4: Analysing and interpreting satellite images for identification of features and events
CO5: Evaluating and modelling scenarios for decision making on resource assessment and planning

MODULE - 1

Introduction to Remote Sensing
Definition; Objectives; Basic principle; Process; Spectral signatures; Platforms; Software; Sensor resolutions; Advantages and limitations; Brief history of remote sensing.

[01]

Basic Concepts of Remote Sensing
Physics of remote sensing; Electromagnetic spectrum; Black body concept; Atmospheric windows; Electromagnetic radiation: wave model and particle model, Stephen Boltzmann Law, Wein's Displacement Law; Energy interaction: Scattering - absorption – reflection.

[03]

Aerial Photography and Photogrammetry
Basic principles; Photographic systems; Advantage and Disadvantages; Vertical aerial photography; Scale of photography; Relief displacement; Stereoscopy; Vertical exaggeration; Elements of image interpretation.

[03]

MODULE - 2

Satellite Sensors
Imagining systems; Working principle; Geometry of scanners; CCD arrays and platforms; Satellite orbits; History of space imaging; Satellite missions - LANDSAT, SPOT, IRS etc.; Characteristics of sensors: MSS, TM, LISS – I to IV, Outputs from various sensors.

[03]

Image Visualisation

Image geometric distortions; Digital image data formats; Image types; Colour theory, False Colour Composites, Band combinations; Band ratio, NDVI.

[02]

Digital Image Processing

Geometric and radiometric corrections of images; Ground Control Points, Root Mean Square Error; Image resampling; Image contrast enhancement; Image filtering, Linear edge detection and enhancement; Principal Component Analysis; Intensity-Hue-Saturation; Image fusion and resolution merge.

[03]

MODULE - 3

Digital Image Classification

Classification techniques: Parametric, non-parametric, non-metric, hard rule and fuzzy rule based, Supervised and unsupervised, per-pixel and object-oriented classification; Clustering techniques; Accuracy assessment; Linear mixture modelling; ANN based classification; Digital change detection; Change detection techniques; Spectral change vector analysis; Error matrix.

[05]

Beyond Optical Remote Sensing

Thermal Infra-Red remote sensing; Heat energy budget; Brightness temperature and Emissivity; Hyperspectral remote sensing; Microwave remote sensing: passive and active sensing; Imagining RADAR, LIDAR and SONAR; Applications.

[03]

MODULE - 4

Fundamentals of Geographic Information Systems

Definition; History; Components; Elements of GIS; Data types; Measurement scales of attribute data; Coordinate systems and geo-referencing; Map projections; Coordinate transformations; Resampling; Raster and Vector models; Topology concept; DTM and TIN models; Map digitization.

[05]

Data, Database, and Data Analysis

Data structures and models; Database management system; Database structures; Database creation; Client-server Network web GISl; Data analysis functions; GIS queries; GIS measurements: Raster versus Vector; Distance measurements; Proximity analysis; Reclassification; Buffering; Raster GIS filtering; Boolean operations; Map overlay; Site suitability analysis and zoning.

[05]

MODULE - 5

GIS Analysis and Modelling

Terrain Analysis: Interpolation techniques; Extraction of terrain parameters: slope, aspect, curvature, hill shading, view shed analysis, contouring.

Network Analysis: Definition and concept of network; Types of network analysis examples: shortest path problem, travelling salesperson's problem, location-allocation modelling, route tracing; Geocoding; Path analysis.

GIS Modelling: Process modelling in GIS (natural and scale analog models, conceptual models, mathematical models); multi-criteria evaluation; Criteria weighting: rating, ranking, and pair-wise comparison; Analytic Hierarchic Process (AHP).

[04]

Integrated Remote Sensing and GIS Applications

Natural resources assessment: Identification of minerals and ore deposits; groundwater potential modeling, groundwater quality zoning, aquifer vulnerability assessment, soil moisture estimation etc.

Natural hazards: Zoning and micro-zoning for landslide, earthquake, avalanche, beach erosion, land subsidence etc., flood inundation mapping, flood-risk zoning; snow melt initiation; drought and water-scarcity.

Urban and regional planning: mapping and monitoring urban growth and changes; land use/land cover mapping; land degradation; deforestation; desertification; basin erosion; sedimentation; hazard and risk assessment, forecasting etc.

[05]

Total contact hours: **42**

Textbooks and Reference Books:

1. Paul R Wolf, **Elements of Photogrammetry**, McGraw Hill.
2. Lillesand and Kiefer, **Remote sensing and Image Interpretation**, John Wiley and Sons.
3. Ravi R Gupta, **Remote Sensing Geology**, Springer
4. Floyd F Sabins, **Remote Sensing Principles and Interpretation**, WH Freeman and Co.
5. John R Jenson**, Introductory Digital Image Processing**, Prentice Hall.
6. Burrough P A, **Principles of Geographical Information System for Land Resource Assessment,** Oxford University Press.
7. Bonham-Carter G F, **Geographic information systems for geoscientists: modelling with GIS** (1995) Pergamon.
9. Hall M K, Schaller C J, Walker C S, and Kendal L P, **Exploring Water Resources: GIS Investigations for the Earth Sciences** (2002), Brooks Cole

(SEMESTER VI)

CE 307A3 ADVANCED STRUCTURAL ANALYSIS

[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. To understand the concept of indeterminacy and analysis of indeterminate structures.
2. Evaluation of shape factor, collapse load, and plastic moment carrying capacity of structures using the concept of plastic analysis.
3. Analysis of indeterminate beams, trusses and frames by matrix method.
4. Ability to solve problems related to influence lines.
5. Ability to analyze the problems of beams and frames by Column Analogy method.

Module – 1: Introduction

Classification of structures, equation of static equilibrium, internal forces, free-body diagram, degree of static indeterminacy, degree of kinematic indeterminacy, stability. Column Analogy method - Introduction, Sign convention, stresses in a column, application to beams, application to symmetric frames.

[09]

Module - 2: Plastic Analysis

Ductility behavior in the plastic range, concept of plastic hinge, plastic moments, shape factor for different shapes of cross section, redistribution of moment, collapse mechanism. Upper and lower bound theorems. Determination of collapse loads using static and kinematics methods for simple structures.

[09]

Module - 3: Analysis by Displacement Method

Matrix formulation of displacement method, generation of 1- dimensional frame element stiffness matrix, flexural, axial and shear deformations, concept of local effects, generation of load vector, effects of finite joints, application to plane frames.

[06]

Module - 4: Analysis by force method

Matrix formulation of force methods, Solution of simultaneous equations generation of 1-dimensional frame element stiffness matrix, flexibility and displacement approaches, concept of local effects, generation of local vector, application to plane frames.

[08]

Module - 5: Influence Lines for Indeterminate Structures

Concept of influence lines using equilibrium methods and by using Muller Breslau principle for both statically determinate and indeterminate structures. [08]

Total contact hours: **40**

References

1. Reddy C S (2004), "**Basic Structural Analysis**", Tata McGraw Hill, New Delhi.
2. Rao Prakash D.S (1996), "**Structural Analysis**" Universities Press, India.
3. Gupta S P, Pandit G S, and Gupta R (2003), "**Theory of Structures**" volume 2, McGraw Hill, New Delhi.
4. Vaidyanathan R, and Perumal R, (2004), "**Comprehensive Structural Analysis**", Vol I & II, Laxmi Publications, New Delhi.

(SEMESTER VI)

CE 308A3 STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. To understand the concept of indeterminacy and analysis of indeterminate structures.
2. Evaluation of shape factor, collapse load, and plastic moment carrying capacity of structures using the concept of plastic analysis.
3. Analysis of indeterminate beams, trusses and frames by matrix method.
4. Ability to solve problems related to influence lines.
5. Ability to analyze the problems of beams and frames by Column Analogy method.

Chapter – 1: Engineering Seismology

Terminology, causes and effects of earthquakes, magnitude and intensity, accelerograms, faults, folds, selection of sites for structures, ground motion in an earthquake, types of seismic waves, seismic zones, modified Mercalli scale.

[06]

Chapter – 2: Introduction

Objectives, dynamic loading, difference between static and dynamic force, types of motions, formulation of equations of motion: (a) D, Alembert's principle (b) Principle of virtual work.

[04]

Chapter – 3: Single Degree of Freedom Systems

(a) Components of the system, types of vibration, undamped and damped free vibrations, logarithmic decrement.
(b) Forced vibrations due to harmonic excitation, steady state and transient response, transmissibility, vibration isolation, evaluation of damping, half power bandwidth method.

[10]

Chapter – 4: Multi-Degree of Freedom Systems

Equations of motion, undamped and damped free vibration, Eigen values and Eigen vectors, orthogonality conditions, power method, characteristic equation method.

[10]

Chapter – 5: Methods of seismic analysis

Seismic design philosophy, equivalent static lateral force method with examples, ductility considerations in earthquake resistant design in RC buildings (IS: 13920)

[10]

Total contact hours: **40**

Reference Books:

1. Rao S D, **Mechanical Vibrations**, Addison Wesely New York
2. Chopra A K, **Dynamics of Structures – Theory and Applications to Earthquake Engineering**, Prentice Hall of India
3. Seto, **Mechanical Vibrations**, Schuam's Outline Series, McGraw Hill Book Co.
4. Jai Krishna, Chandrasekaran A R and Brijesh Chandra, **Elements of Earthquake Engineering**, South Asian Bulishers, New Delhi
5. Thaniby W T, **Theory of Vibrations with Applications**, CBS Publishers
6. Paz M, **Structural Dynamics**, CBS Publishers, New Delhi
7. Mukhopadhay, **Vibrations- Structures and Structural Systems**, Oxford and IBH, New Delhi
8. Biggs J M, **Introduction to Structural Dynamics**, McGraw Hill Publications
9. Claugh and Penzien, **Dynamics of Structures**, McGraw Hill Publications
10. Ghosh S K, **Earthquake Resistant Design of Concrete Structures**, SDCPL-R and d Centre, New Mumbai
11. Humar J C, **Dynamics of Structures**, Prentice Hall N.J.

PROGRAM ELECTIVE V
(SEMESTER VI)

CE 311A3 WASTE WATER ENGINEERING [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):
After completion of this course, students should be able to

1. Design Wastewater Treatment Units with Different Flow Conditions
2. Apply concept of physical and chemical characteristics of wastewater.
3. Understand the safe disposal of wastewater.
4. Compute the quantity of storm and sanitary sewage.
5. Analyse solid waste disposal and Industrial waste management.

Module – 1: Introduction and Characteristics of Sewage
Aim and object of sewage disposal, systems of sanitation, systems of sewage disposal, investigation of sanitary projects. Aerobic and anaerobic process, cycles of decomposition.
[7]

Module – 2: Quantity of Sanitary and Storm Sewage
Design of sewers, flow variations, partial flow diagrams. Laying of sewers, joining and testing of sewers, sewer appurtenances, pumping of sewage, house drainage systems, systems of pumping, typical layout plan showing house drainage.
[12]

Module – 3: Disposal of Sewage
Dilution, self-purification of streams, oxygen sag curve, land disposal - suitability, sewage farming and sewage sickness, septic tanks, oxidation ponds, oxidation ditch, aerated lagoons.
[07]

Module – 4: Treatment of Sewage
Flow diagrams, screens, grit chamber, skimming tank, primary sedimentation, secondary clarifiers.
(a) Secondary Treatment: Trickling filters – theory, parts, operation and design, RBCs activated sludge process – meaning, flow diagram, modifications, bulking of sludge, sludge volume index, sludge disposal, digestion of sludge followed by drying, sludge digesters.
(b) Tertiary Treatment: Chlorination of sewage, coagulation of sewage etc.
[10]

Module – 5: Solid Waste Disposal
Quality and quantity of refuse, collection and conveyance of solid waste, disposal of solid waste by composting and other methods, salvaging, grinding and discharging into sewers.
[04]

Total contact hrs: **40**

Reference Books:

1. Sawyer and McCaurty, **Chemistry for Environmental Engineering**.
2. **IS: Standards**: 2490 – 1974; 3360 – 1974; 3307 – 1974.
3. **Manual on Sewage and Sewage Treatment CPHEO**, Ministry of Urban development, Delhi
4. Garg S K, **Environmental Engineering – II**, Khanna Publishers.
5. Metcalf and Eddy, **Wastewater Engineering**, **Treatment and Reuse**, Tata McGraw Hill
6. **Standard Methods** – APHEA.

CE 312A3 RAILWAYS, AIRPORTS, AND TUNNELLING ENGINEERING
[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Explain the function of various elements of railway engineering.
2. Understand the resistances and its effects on railway.
3. Design of harbours using the governing general principles.
4. To develop knowledge about the different concepts of tunnel engineering including different types of tunneling, tunnel ventilation, dust removal, etc.
5. Explain about layout, design and construction of permanent way, runway and taxiway.

RAILWAY ENGINEERING

Module – 1: Introduction
Railway terminology, reasons for laying a new railway line, factors influencing the proposed route, railway surveys – reconnaissance survey, preliminary survey, location survey.

[04]

Module – 2: Alignment Details
Grades and curves, effects of normal and ruling gradients, use of vertical profile, humps, sags, pusher and balanced grades, super elevation, equilibrium cant, cant deficiency and grade compensation.

[04]

Module – 3: Railway Components
Permanent Way Component parts, ballast, sleepers, rails, fastenings, railway creep, anti-creep devices, guard rails, maintenance and improvement of permanent way, drainage.

[06]

Points and Crossing
Necessity of turnouts, switches, types of track junctions, design of a turn-out.

[09]

Stations and Yards
Types of railway stations, classification of stations and yards.

[02]

Module – 4: Tunnels
Advantages of tunneling, shape, and size of tunnels, tunnel alignment, shafts and pilot tunnels.

[02]

Tunneling through soft rock and soils: Different methods adopted, tunneling using shield, methods of tunneling, lining of tunnels.

[03]

Tunneling through hard rock: Different methods of tunneling through hard rock, grouting and lining of tunnels.

[02]

Miscellaneous topics: Tunnel ventilation, dust removal.

[02]

Module – 9: Airports Factors to be considered in airport planning, ICAO classification of airports, site selection, airport surveys.

[01]

Airport Geometric Standards: Runway length, width, sight distance, grades and change of grades, taxiways, aprons, orientation of runway, effect of wind direction and cross wind component including wind rose diagram.

[02]

Visual Aids – night aids, instrumental landing systems and their functioning.

[03]

Total contact hours: **40**

Reference Books

1. Anita, **Railway Engineering**.
2. Agarwal and Soudhi**, Introduction to Railway Engineering.**
3. Arora and Saxena, **A Text Book of Railway Engineering**
4. Rangwala, **Railway Engineering**
5. Vazirani and Chandola, **Transportation Engineering**
6. Srinivasan, **Dock, Harbours and Tunnels**.
7. Morgan, **Harbours.**
8. Khanna, Arora and Jain, **Airport Planning and Design**.
9. Sehgal and Bhanot, **A Text Book on Highway Engineering and Airport**

(SEMESTER VI)

CE 313A3 BRIDGE ENGINEERING [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to :

1. Remembering the basic principle to investigate bridge.
2. Understanding the standard specification of road bridges as per IS Codes.
3. Analysis of culverts.
4. Ability to design concrete bridges.
5. Interpret the various properties of substructures and super structures of bridges.

Module 1: Introduction

Definitions, components of a bridge, classification, importance and standard specifications. Site selection, data drawing, design discharge, linear water way, economical span, location of piers and abutments, vertical clearance above HFL, scour depth, traffic projection, investigation report, choice of bridge type.

[07]

Module – 2: Standard specifications for road bridges

IRC bridge code, determination of dead loads and live loads, wind loads, longitudinal forces, centrifugal forces, horizontal forces due to water current, buoyancy effect, earth pressure, temperature effect, deformation stresses, secondary stresses, erection stresses, seismic forces.

[08]

Module - 3: Culverts and Concrete bridges

RCC slab culvert, pipe culvert and box culvert. Concrete bridges- Analysis and design of small bridges and culverts, structural details of Specialization bridges and culverts, T-beam reinforces concrete bridges and pre-stressed concrete bridges, continuous bridges, cantilever bridges.

[10]

Module - 4: Sub structures

Different types of bridge bearings, piers and masonry abutments, different types of foundation and their choices, wing walls, abutment and pier design for Specialization bridges, depth of bridge foundation, length of clear span and number of spans and the effect of contraction on the normal scour depth, return wall, wing wall.

[07]

Module – 5: Super structures

Construction of superstructures for temporary bridges, semi-permanent bridges, submergible bridges, low-cost bridges, steel-arch bridges, RCC bridges and cable stayed bridges, wearing course, expansion joint, approach road, approach slab, protection works for shallow foundation for Specialization bridges, special precautions during construction, failure and restoration of bridge super structure, sub-structure and its maintenance.

[08]

Total contact hours: **40**

References

1. Ponnuswamy S, "**Bridge Engineering**", Tata McGraw Hill Publishing Co., New Delhi, 2003.
2. Whitney C.S, "**Bridges**", Greenwich House 1983.
3. N.K. Raju, "**Design of bridges**", Oxford & IBH Publishing Co. pvt. ltd.
4. D.J. Victor, "**Essentials of bridge engineering**", Oxford & IBH Publishing Co. pvt. Ltd.
5. Indian Road Congress Codes"

(SEMESTER VI)

CE 314A3 ADVANCED FOUNDATION ENGINEERING
[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. To evaluate the bearing capacity with different methods.
2. To design pile and pile cap.
3. To analyze and design foundation on expansive soil.
4. To understand the concept of machine foundation
5. To apply ground improvement techniques to improve the strength and bearing capacity.

Module – 1: Bearing Capacity and Design of Piles and Pile caps

Brinch Hansen's, Meyerhoff's and Skempton's bearing capacity equations. Plate load test and penetration tests. Design principles of shallow foundations, Isolated, combined and raft foundations. Brom's theory. Principles of design of sheet and anchor bulkhead.

[11]

Module - 2: Well foundation

Bearing capacity, lateral stability. Terzaghi's method and IRC method.

[04]

Module – 3: Foundation on Expansive Soils

Problems of foundations on expansive soils. Remedial measures.

[04]

Module – 4: Coffer dams and Machine foundations

Types, design and analysis for stability. Degree of freedom – general criteria, mass-spring-dash-pot model. Block foundation subjected to vertical, horizontal and rocking vibrations. Elastic half space approach. Vibration isolation.

[13]

Module – 5: Ground Improvement Techniques

Necessity, traditional methods, reinforced earth structures. Materials, application and design principles. Principles and construction of granular piles, sand drains, geodrains, lime columns.

[08]

Total contact hours: **40**

Reference Books

1. Bowles J E, (1997), "**Foundation Analysis and Design**", McGraw Hill, New York.
2. Winterkorn H F and Fange H Y, (1991), "**Foundation Engineering Hand book**", Van Nostand Reinhold Company, New York.
3. Teng W C, (1981), "**Foundation Design**", Prentice Hall of India", New Delhi.
4. Srinivaslu P and Vaidyanathan C V, (1987), "**Hand Book of Machine Foundations**", Tata McGraw Hill.
5. Poulos H G and Davis E H, (1980), "**Pile Foundation Analysis and Design**", John Wiley and Sons, New York.

OPEN ELECTIVES / SPECIALIZATIONS

List of Open Electives / Specializations

Specialization	Semester	Subject Code	Subject name
Natural Hazards and Disaster Management	III	CE201A2/A8	Engineering Geology
	IV	CE204A2/A8	Natural Hazards
	V	CE301A2/A8	Engineering Seismology
	VI	CE305A2/A8	Flood & Drought
	VII	CE401A2/A8	Landside Hazard
	VIII	CE405A2/A8	Disaster Management
Earthquake Engineering	III	CE201A2/A8	Engineering Geology
	IV	CE205A2/A8	Numerical Methods & Statistics
	V	CE301A2/A8	Engineering Seismology
	VI	CE306A2/A8	Introduction to Structural Dynamics
	VII	CE402A2/A8	Earthquake resistant Design and Construction
	VIII	CE406A2/A8	Disaster Management
Geoinformatics	III	CE202A2/A8	Remote Sensing
	IV	CE206A2/A8	Geographic Information Systems
	V	CE303A2/A8	Digital Image Processing
	VI	CE307A2/A8	Pattern Recognition
	VII	CE403A2/A8	Adv. Remote Sensing Techniques
	VIII	CE407A2/A8	Adv. Geospatial Modelling
Environmental Engineering	III	CE203A2/A8	Environment Management
	IV	CE207A2/A8	Solid Waste Management
	V	CE304A2/A8	Air Pollution and Control
	VI	CE308A2/A8	Hazardous Waste Management
	VII	CE404A2/A8	Environmental Impact Assessment
	VIII	CE408A2/A8	Sustainable Engineering Concepts and Life Cycle Analysis

Prof. (Dr.) Chandrashekhar Bhuiyan
(Professor & Head)

Mr. Sajal Sarkar
(Assistant Professor –SG)

Mr. Guru Prasad Sharma
(Assistant Professor –SG)

NATURAL HAZARD
AND
DISASTER MANAGEMENT

(Semester: III)

CE 201A2/A8 ENGINEERING GEOLOGY [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Remembering the properties of minerals and rocks, processes of their formation, and their relevance in Civil Engineering.
2. Interpretation of various geological structures, their roles and influences on Civil Engineering planning and construction.
3. Applying the concept of hydrogeology for assessment and management of water resources
4. Analysing the geological set-up to evaluate suitability of sites and stability of Civil Engineering structures.
5. Understanding the working principles and applications of various geophysical techniques for interpretation of subsurface geology.

MODULE 1

Introduction
Geology and Civil Engineering, Earth as a planet, its structure and composition.

[02]

Mineralogy and Petrology
Sources of rocks and minerals, important rock forming and ore minerals, Rock types (Igneous, Sedimentary, Metamorphic), texture and structure in rocks, Rock cycle, Engineering properties of rocks.

[06]

MODULE 2

Physical Geology
Weathering of rocks, kinds of weathering, agencies, causes and products of weathering. Geological works of wind, rivers, glaciers, and groundwater on rocks.

[04]

Structural Geology
Outcrop, dip and strike, clinometer, compass. Folds, faults, joints and unconformity and their recognition in the field and their importance in Civil Engineering projects.

[04]

MODULE 3

Engineering Geology

Geological consideration in selection of sites for dams and reservoirs, tunnels, bridges and highways, landslides – their causes and prevention. Earthquake waves, seismic zones of India and world, earthquakes in India, causes and effects, micro-seismic zoning, engineering consideration against earthquakes.

[08]

MODULE 4

Engineering Properties of Rocks

Test for engineering properties of rocks, Tests for rocks used as foundation sites of construction, Tests for rocks used as building stones, Tests for rocks used as aggregates.

[03]

Rock Mechanics

Introduction to rock mechanics and rock engineering, simple failure criteria, Rock masses: strength, deformability, failure criteria, Rock mass classification schemes: Q and RMR, Foundations and slope stability: foundations on discontinuous rock, slope instability basic mechanisms and static equilibrium solutions, Q and RMR.

[05]

MODULE 5

Geophysical Techniques

Different types of geophysical techniques: gravity, magnetic, electrical resistivity, electromagnetic, seismic methods; Theories, working principles, instruments, advantages and disadvantages; Various applications.

[04]

Hydrogeology

Occurrence of ground water, types of aquifers, aquifer properties, factors controlling aquifer recharge and yield, geo-hydrological zones in India, groundwater development in India, fracture characterisation, well site selection, hydrogeological investigations.

[04]

Total contact hours: **40**

Reference Books:

1. Mukherjee P K, **A Text Book of Geology.**
2. Breth F G H and De Freitas, **Geology for Engineering**.
3. Krayrine and Judd, **Principles of Engineering Geology and Geotechnics**.
4. Gokhale W, **Manual of Geological Maps** (1987) CBS Publishers, New Delhi.
5. Fetter C W, **Applied Hydrogeology** (2000), Prentice Hall; 4 edition
6. Singhal BBS and Gupta RP, **Applied Hydrogeology of Fractured Rocks** (1999), Springer
7. Goodman R E, **Introduction to Rock Mechanics** (1989), Wiley, 2nd edition.
8. N Chenna Kesavulu, **Textbook of Engineering Geology** (2020), Trinity Press, 3rd edition.

(Semester: IV)

CE 202A2/A8 NATURAL HAZARDS [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Understand the nature of various types of natural hazards.
2. Explain the causes and impacts of natural hazards on the environment and society.
3. Analise the mechanism of earthquake, tsunami, and volcanism.
4. Identify zones vulnerable to landslides and land subsidence.
5. Evaluate and predict hydrological hazards such as drought and flood.

MODULE 1
Basic idea of Natural hazards and disasters, Different types of natural hazards, Causes of natural hazards: endogenous and exogenous processes, Human intervention and influence on natural hazards.

[08]

MODULE 2
Plate tectonics and its effect, Earthquakes and their causes, Ground motion and failures, Earthquake hazard zoning, Tsunami: generation and movement, Giant tsunamis, Tsunami hazard assessment, Volcanic hazard.

[08]

MODULE 3
Landslide and their causes, Type of downslope movement, Causes and triggers, Slope stability and failure, Mohr's hypothesis, Coulomb's failure criterion, Land subsidence.

[08]

MODULE 2
Climatological factors and meteorological hazards, Storms: Tropical Cyclone, Hurricane, Tornado, Storm damage and safety measures, Wildfires.

[08]

MODULE 5
Hydrological hazards: brief idea, Flood - causes and impacts, Floods and human interaction, Flood frequency and recurrence interval, Flood inundation modelling, Drought - causes and types, Difference between drought and aridity, Drought and water scarcity, Drought severity assessment, Drought mitigation.

[08]

Total contact hours: **40**

Reference Books
Natural hazard risk assessment and public policy. Petak, W.J. and Atkinson, A.D. Springer Verlag, NY.

(Semester: V)

CE 301A2/A8 ENGINEERING SEISMOLOGY [3 1 0 4]

Course Outcomes:

CO1: Critical understanding of advanced seismology and causes of earthquakes.
CO2: Remembering the seismic hazard and a detailed understanding of wave equations and their solutions.
CO3: Assess the design basis ground motion parameters and its application in earthquake engineering for disaster mitigation.
CO4: Processing, analysis and interpretation of earthquake data, determination of magnitude, epicentral distance, focal depth, focal mechanism, seismic hazard and risk, seismic zoning.
CO5: Prediction of earthquake – a brief idea.

Module no.	Description	Hours
01.	Propagation of earthquake Waves, Body & surface waves, laws of reflection, refraction and attenuation, travel times curves, internal structure of earth.	**8**
02.	Seismicity of earth, major earthquakes in the world, important Indian Earthquakes, earthquake catalogs, plate tectonics, causes of earthquakes. Magnitude, energy, intensity, acceleration, return period, frequency, Ground motion characteristics.	**12**
03.	Earthquake recording instruments, seismographs, different modes of recording analogue, digital, micro earthquake, teleseismic, local, strong motion, band width and their engineering implications.	**8**
04.	Processing, analysis and interpretation of earthquake data, determination of magnitude, epicentral distance, focal depth, focal mechanism, seismic hazard and risk, seismic zoning.	**8**
05.	Introduction to earthquake prediction– a brief idea.	**4**
	Total	**40**

References:

1. Richter,C.F. Elementary Seismology,Eurasia Publishing House (Pvt)LTD,New Delhi
2. Agrawal,P.N.,Engineering Seismology,Oxford & IBH Publishing Co.Pvt.Ltd,New Delhi
3. Aki,K and Richard, P.G.Quantitative seismology, Theory and Methods,Vol.I and II,W.H. Freeman & Co.
4. Rikitake,T.,1976 Earthquake Prediction, Elsevier Science, Amsterdam
5. Oldham,1989 Report on Great Earthquake of 12th June 1897, Memoir Geological Survey of India,V29.
6. Latest Codes of IS-1893-part-I 2016.

(Semester: VI)

CE 305A2/A8 FLOOD AND DROUGHT [3 1 0 4]

Course Outcomes:
CO1: An understanding of flood and flood routing.
CO2: An understanding of the Drought and Drought management system.
CO3: To know the water resources scenario in India.

Module no.	Description	Hours
1	**Introduction:** Definition and scope of the subject, Flood and drought with human Introduction	03
2	**Flood:** Rational Method, Empirical Formulae, Unit Hydrograph Method, Flood Frequency Method, Gumbel's Method, Log-Pearson Type III Distribution, Partial duration series, Regional Flood Frequency Analysis, Extremes of Extremes-Envelope curve, Data for frequency studies, Design Flood, Design. Storm, Risk, Reliability and safety factor	12
3	**Flood Routing:** Introduction, Basic equations, Level pool routing, Attenuation, Hydrologic Channel routing, Hydraulic method of flood routing, Clark's method for IUH, Nash conceptual model, Flood control, Flood control in India.	07
4	**Drought:** Classification, Types of drought, Aridity Index, Impact of drought, Possible modification of drought components **Drought Management: Definition**, Water Harvesting, Rain water Harvesting, Flood water harvesting, Different types of water harvesting	12
5	**Droughts in India:** Causes, Status, Surface water resources of India Utilizable water resources, Total water requirement and available water Resources scenario in India	06
	Total	40

References:

1. Ven te Chow, Applied Hydrology, McGraw Hill.
2. Subramanya K, Engineering Hydrology, Tata McGraw Hill.
3. VP Singh, D Jhajharia, R Mirabbasi, R Kumar, Integrated Drought Management, CRC Press
4. D Wilhite and RS Pulwarty, Drought and Water Crises: Integrating Science, Management, and Policy, Second Edition, CRC Press
5. AS Schumann, Flood Risk Assessment and Management, Springer

(Semester: VII)

CE 401A2/A8 LANDSLIDE HAZARD [3 1 0 4]

Course Outcomes:
CO1: Students will gain a basic knowledge of landslides and factors causing landslides.
CO2: Students will gain a detailed knowledge of classification and mapping of landslides.
CO3: Students will gain a detailed understanding of landslide-hazard and stability of slopes.
CO4: Students will gain a detailed understanding of landslides control measures and case studies of landslides.

Module no.	Description	Hours
1	**Introduction: Definition;** overview of Hazard assessment techniques on regional, semi detail and detailed scales and their application for planning purposes; Terrain classification and ma in methods, use of RS and GIS.	04
2	**Factors for landslide:** Causative factors of landslides natural including inherent factors and external factors as well as anthropogenic factors; Impacts of natural causative factors like lithology, structure, slope morphometry, relative relief, hydrogeological conditions and land use and land cover on stability of slopes Impacts of external factors like concentrated rain fall and earth quakes on slope stability; Various causes of slope instability in Himalaya; extreme hydro-meteorological conditions leading to landslide dams and Related damages	10
3	**Classification and Mapping:** Classification of landslides and mass movements, Landslide hazard zonation (LHZ) on regional scales in India; LHZ mapping technique suggested by Bureau of Indian Standards with exam les; Application of regional scale LHZ maps.	06
4	**Landslide hazard studies and stability of slopes:** Landslide hazard studies on detailed scale of 1: 1000; Mechanics of landslide; Markland test for landslide probability, Strength of slope materials; Assessment of rock mass properties; Overview of slope stability studies for slopes characterized by overburden debris and rock materials.	06
5	**Landslide Control Measures:** Landslide control measures – grading of slopes, retaining walls, breast walls, drainage measures, rock bolts and rock anchors, Biotechnical measures, Special toe walls and other stability Measures. **Case studies in India:** Case studies of important landslides of Himalaya and their control practices.	14
	Total	40

References:

1. Mitigation of Natural hazards and Disasters: International perspective. Haque, C. Emdad, Springer, Dordrecht. Mutreja.
2. Environmental geosciences. Keller, EA. John Wiley & Sons, NY.
3. Natural hazard risk assessment and Public policy. Petak, W.J. and Atkinson, A.D. Springer Verlag, NY.
4. Subramanya K, Engineering Hydrology, Tata McGraw Hill.
5. A field manual for landslide investigations, R. Anbalagan, B. Singh, D. Chakraborthy and A. Kohli. DST Government of India, New Delhi.

(Semester: VIII)

CE 405A2/A8 DISASTER MANAGEMENT [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Understanding of Disaster management and Risk and Vulnerability Analysis of Disaster.
2. Establishment of Disaster Preparedness and Response.
3. Categorize Rehabilitation, Reconstruction and Recovery.
4. Understand Disaster Response Plan

Module no.	Description	Hours
1	Introduction on Disaster: Different Types of Disaster : A) Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc B) Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea,Rail& Road), Structural failures(Building and Bridge),War & Terrorism etc. Causes, effects and practical examples for all disasters.	**10**
2	Risk and Vulnerability Analysis: 1. Risk: Its concept and analysis 2. Risk Reduction 3. Vulnerability: Its concept and analysis 4. Strategic Development for Vulnerability Reduction.	**08**
3	Disaster Preparedness and Response: Preparedness- 1. Disaster Preparedness: Concept and Nature 2. Disaster Preparedness Plan 3. Prediction, Early Warnings and Safety Measures of Disaster. 4. Role of Information, Education, Communication, And Training. 5. Role of Government, International and NGO Bodies. 6. Role of IT in Disaster Preparedness 7. Role of Engineers on Disaster Management. Response	**06**

4	Disaster Response: Introduction 1. Disaster Response Plan 2. Communication, Participation, and Activation of Emergency Preparedness Plan 3. Search, Rescue, Evacuation and Logistic Management 4. Role of Government, International and NGO Bodies 5. Psychological Response and Management (Trauma,Stress, Rumor and Panic) 6. Relief and Recovery 8. Medical Health Response to Different Disasters	**06**
5	Rehabilitation, Reconstruction and Recovery: 1. Reconstruction and Rehabilitation as a Means of Development. 2. Damage Assessment 3. Post Disaster effects And Remedial Measures. 4. Creation of Long-term Job Opportunities and Livelihood Options, 5. Disaster Resistant House Construction 6. Sanitation and Hygiene 7. Education and Awareness, 8. Dealing with Victims' Psychology. 9. Long-term Counter Disaster Planning 10. Role of Educational Institute.	**08**
	Total	**38**

References:

1. Dr. Mrinalini Pandey. Disaster Management. Wiley India Pvt. Ltd.
2. Jagbir Singh. Disaster Management: Future Challenges and Opportunities. Publishers Pvt. Ltd.
3. J. P. Singhal. Disaster Management. Laxmi Publications.
4. Shailesh Shukla, Shamna. Biodiversity, Environment and Disaster Management. Unique Publications.

EARTHQUAKE ENGINEERING

(Semester: III)

CE 201A2/A8 ENGINEERING GEOLOGY [3 0 1 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

6. Remembering the properties of minerals and rocks, processes of their formation, and their relevance in Civil Engineering.
7. Interpretation of various geological structures, their roles and influences on Civil Engineering planning and construction.
8. Applying the concept of hydrogeology for assessment and management of water resources
9. Analysing the geological set-up to evaluate suitability of sites and stability of Civil Engineering structures.
10. Understanding the working principles and applications of various geophysical techniques for interpretation of subsurface geology.

MODULE 1

Introduction
Geology and Civil Engineering, earth as a planet, its structure and composition.

[01]

Mineralogy and Petrology
Sources of rocks and minerals, important rock forming and ore minerals, Rock types (Igneous, Sedimentary, Metamorphic), texture and structure in rocks, Rock cycle, Engineering properties of rocks.

[06]

MODULE 2

Physical Geology
Weathering of rocks, kinds of weathering, agencies, causes and products of weathering. Geological works of wind, rivers, glaciers, and groundwater on rocks.

[04]

Structural Geology
Outcrop, dip and strike, clinometer, compass. Folds, faults, joints and unconformity and their recognition in the field and their importance in Civil Engineering projects.

[04]

MODULE 3

Engineering Geology

Geological consideration in selection of sites for dams and reservoirs, tunnels, bridges and highways, landslides – their causes and prevention. Earthquake waves, seismic zones of India and world, earthquakes in India, causes and effects, micro-seismic zoning, engineering consideration against earthquakes.

[08]

MODULE 4

Engineering Properties of Rocks

Test for engineering properties of rocks, Tests for rocks used as foundation sites of construction, Tests for rocks used as building stones, Tests for rocks used as aggregates.

[03]

Rock Mechanics

Introduction to rock mechanics and rock engineering, simple failure criteria, Rock masses: strength, deformability, failure criteria, Rock mass classification schemes: Q and RMR, Foundations and slope stability: foundations on discontinuous rock, slope instability basic mechanisms and static equilibrium solutions, Q and RMR.

[06]

MODULE 5

Geophysical Techniques

Different types of geophysical techniques: gravity, magnetic, electrical resistivity, electromagnetic, seismic methods; Theories, working principles, instruments, advantages and disadvantages; Various applications.

[04]

Hydrogeology

Occurrence of ground water, types of aquifers, aquifer properties, factors controlling aquifer recharge and yield, geo-hydrological zones in India, groundwater development in India, fracture characterisation, well site selection, hydrogeological investigations.

[04]

Total contact hours: **40**

Reference Books:

1. Mukherjee P K, **A Text Book of Geology**.
2. Breth F G H and De Freitas, **Geology for Engineering**.
3. Krayrine and Judd, **Principles of Engineering Geology and Geotechnics**.
4. Gokhale W, **Manual of Geological Maps** (1987) CBS Publishers, New Delhi.
5. Fetter C W, **Applied Hydrogeology** (2000), Prentice Hall; 4 edition
6. Singhal BBS and Gupta RP, **Applied Hydrogeology of Fractured Rocks** (1999), Springer
7. Goodman R E, **Introduction to Rock Mechanics** (1989), Wiley, 2nd edition.
8. N Chenna Kesavulu, **Textbook of Engineering Geology** (2020), Trinity Press, 3rd edition.

(Semester: IV)

CE 205A2/A8 NUMERICAL METHODS AND STATISTICS
[3 1 0 4]

SCHEME OF EXAMINATION

Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

After completion of this course, students should be able to

1. Understanding and remembering the important formulae and equations for numerical analysis.
2. Executing various numerical techniques and methods for problem solving.
3. Applying the differential techniques, interpolation and integration for determining response of beams.
4. Evaluating the various solution of non-linear and differential equations.
5. Analysing and justifying solutions based on curve fittings techniques.

Module – 1:

i) Linear Algebraic Equations

(a) Gauss Elimination method
(b) Gauss Jordan Elimination Method
(c) Choloskey Decomposition method
(d) Gauss Siedal and Jacobi Iterative methods.

ii) Solution of Non-linear Equations

(a) Bisection method
(b) Newton - Raphson method

[08]

Module – 2:

i) Numerical Integration

(a) Trapezoidal rule
(b) Simpsons rule

[04]

ii)Numerical Differentiation

(a) Forward Difference
(b) Backward Difference
(c) Central Difference
(d) Taylor Series

[04]

iii) Solution of Differential Equations

(a) Runga-Kutta method
(b) Adams – Bashforth method

[03]

Module – 3:

i) Descriptive Statistics

Measures of Central Tendency
Measures of Dispersion
Measures of Skewness
Measures of Relationship [06]

ii) Testing of Hypothesis

Basic concepts concerning Testing of Hypothesis
Procedure of Hypothesis Testing [03]

Module – 4:

Analysis of Variance

Basic principle of ANOVA
One Way ANOVA
Two Way ANOVA
Analysis of Co-variance (ANOCOVA) [06]

Module – 5:

Linear Regression Analysis

Dependent and Independent variables
Simple Linear Regression Model
Multiple Linear Regression Model [06]

Total contact hours: **40**

Reference Books:

1. Dr. P. Kandasamy, **Numerical Methods**, S.Chand, New Delhi.
2. Krishnaraju N and Muthu K U, **Numerical Methods for Engineering Problems**, Macmilan India, New Delhi.
3. Sastry S S, **Introductory Methods of numerical Analysis**, Prentice Hall of India
4. Rajasekaran S, **Numerical Methods for Science and Engineering**, Wheeler and Co.Pvt Ltd.
5. C.R. Kothari and Gaurav Garg, **Research Methodology, New Age International (P) Limited, Publishers.**

(Semester: V)

CE 301A2/A8 ENGINEERING SEISMOLOGY [3 1 0 4]

Course Outcomes:

CO1: Critical understanding of advanced seismology and causes of earthquakes.
CO2: Remembering the seismic hazard and a detailed understanding of wave equations and their solutions.
CO3: Assess the design basis ground motion parameters and its application in earthquake engineering for disaster mitigation.
CO4: Processing, analysis and interpretation of earthquake data, determination of magnitude, epicentral distance, focal depth, focal mechanism, seismic hazard and risk, seismic zoning.
CO5: Prediction of earthquake – a brief idea.

Module no.	Description	Hours
01.	Propagation of earthquake Waves, Body & surface waves, laws of reflection, refraction and attenuation, travel times curves, internal structure of earth.	**8**
02.	Seismicity of earth, major earthquakes in the world, important Indian Earthquakes, earthquake catalogs, plate tectonics, causes of earthquakes. Magnitude, energy, intensity, acceleration, return period, frequency, Ground motion characteristics.	**12**
03.	Earthquake recording instruments, seismographs, different modes of recording analogue, digital, micro earthquake, teleseismic, local, strong motion, band width and their engineering implications.	**8**
04.	Processing, analysis and interpretation of earthquake data, determination of magnitude, epicentral distance, focal depth, focal mechanism, seismic hazard and risk, seismic zoning.	**8**
05.	Introduction to earthquake prediction– a brief idea.	**4**
	Total	**40**

References:

1. Richter,C.F. Elementary Seismology,Eurasia Publishing House (Pvt)LTD,New Delhi
2. Agrawal,P.N.,Engineering Seismology,Oxford & IBH Publishing Co.Pvt.Ltd,New Delhi
3. Aki,K and Richard, P.G.Quantitative seismology, Theory and Methods,Vol.I and II,W.H. Freeman & Co.
4. Rikitake,T.,1976 Earthquake Prediction, Elsevier Science, Amsterdam
5. Oldham,1989 Report on Great Earthquake of 12th June 1897, Memoir Geological Survey of India,V29.
6. Latest Codes of IS-1893-part-I 2016.

(Semester: VI)

CE 306A2/A8 INTRODUCTION TO STRUCTURAL DYNAMICS
[3 1 0 4]

Course Outcomes:
CO1: Understanding the basic knowledge of structural dynamics.
CO2: Remembering and understanding the Single degree of freedom system.
CO3: Application of Multi degree of freedom system in earthquake engineering.
CO4: Analysis of the analysis of multi-degree of freedom un-damped systems – Raleigh method, Power Method
CO5: Analysis of static and dynamic structures.

Module no.	Description	Hours
01.	**Introduction:** Objectives, dynamic loading, types of dynamic problems. Formulation of equations of motion: a) D'Alembert's principle, b) Principle of virtual work c) Variational approach.	**04**
02.	**Single Degree of Freedom Systems:** Components of the system, un-damped and damped free vibrations, logarithmic decrement, forced vibrations due to harmonic excitation – steady state and transient response, transmissibility, vibration isolation, Forced vibrations due to general dynamic loading.	**14**
03.	**Multi-Degree of Freedom Systems:** Equations of motion, un-damped and damped free vibration, eigenvalues and eigen vectors, orthogonality conditions.	**08**
04.	**Damping**: Free vibration of shear buildings with and without damping, Approximate methods for the analysis of multi-degree of freedom un-damped systems – Raleigh method, Power Method.	**04**
05.	**Static and dynamic Analysis of structures:** Static and Response spectrum and Time history method.	**08**
	Total	**38**

References:

1. Rao, S.D., (1995), 'Mechanical Vibrations',3rd ed., Addison Wesely, New York, 19.
2. Chopra A.K., (2001), 'Dynamics of structures– Theory and application to Earthquake Engg.' Prentice - Hall of India Pvt. Ltd. New Delhi.
3. Seto, (1964), 'Mechanical vibrations, Schuam's Outline Series', McGraw Hill, New York.
4. Jai Krishna, Chandrasekaran, A.R. and Brijesh Chandra, (1994), 'Elements of Earthquake Engg'., 2nd ed., South Asian Publishers, New Delhi,
5. Thansi by W.T, (1988), 'Theory of vibration – with Applications', C.B.S. Publishers and Distributors, New Delhi.
6. Paz. M, (2004), 'Structural Dynamics', 2nd ed., C.B.S. Publishers, New Delhi.
7. Mukhopadhay., (2000), 'Vibrations of structures and structural systems' Oxford and IBH, New Delhi.
8. Biggs J.M., 'Introduction to structural dynamics', McGraw Hill publications.
9. Clough and Penzien, (1993), 'Dynamics of structures' – McGraw Hill publications.

(Semester: VII)

CE 406A2/A8 DISASTER MANAGEMENT [3 1 0 4]

Course Outcomes:
CO1: Students who take this course will gain a thorough, critical understanding of Disaster management and Risk and Vulnerability Analysis of Disaster.
CO2: Students will gain a detailed understanding of Disaster Preparedness and Response.
CO3: Students will gain a detailed understanding of Rehabilitation, Reconstruction and Recovery.

Module no.	Description		Hours
1	Introduction on Disaster: Different Types of Disaster : C) Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc D) Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc. Causes, effects and practical examples for all disasters.		**10**
2	Risk and Vulnerability Analysis: 1. Risk: Its concept and analysis 2. Risk Reduction 3. Vulnerability: Its concept and analysis 4. Strategic Development for Vulnerability Reduction.		**10**
3	Disaster Preparedness and Response: Preparedness- 1. Disaster Preparedness: Concept and Nature 2. Disaster Preparedness Plan 3. Prediction, Early Warnings and Safety Measures of Disaster. 4. Role of Information, Education, Communication, And Training. 5. Role of Government, International and NGO Bodies. 6. Role of IT in Disaster Preparedness 7. Role of Engineers on Disaster Management. Response 8. Disaster Response: Introduction 9. Disaster Response Plan 10. Communication, Participation, and Activation of Emergency Preparedness Plan		**12**

	11. Search, Rescue, Evacuation and Logistic Management 12. Role of Government, International and NGO Bodies 13. Psychological Response and Management (Trauma, Stress, Rumor and Panic) 14. Relief and Recovery 15. Medical Health Response to Different Disasters		
4	Rehabilitation, Reconstruction and Recovery: 1. Reconstruction and Rehabilitation as a Means of Development. 2. Damage Assessment 3. Post Disaster effects And Remedial Measures. 4. Creation of Long-term Job Opportunities and Livelihood Options, 5. Disaster Resistant House Construction 6. Sanitation and Hygiene 7. Education and Awareness, 8. Dealing with Victims' Psychology. 9. Long-term Counter Disaster Planning 10. Role of Educational Institute.		**08**
	Total		**40**

References:

1. Dr. Mrinalini Pandey. Disaster Management. Wiley India Pvt. Ltd.
2. Jagbir Singh. Disaster Management: Future Challenges and Opportunities. Publishers Pvt. Ltd.
3. J. P. Singhal. Disaster Management. Laxmi Publications.
4. Shailesh Shukla, Shamna. Biodiversity, Environment and Disaster Management. Unique Publications.

GEOINFORMATICS

(Semester: III)

CE 202A2/A8 REMOTE SENSING [3 1 0 4]

SCHEME OF EXAMINATION

Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

CO1: Remembering the basic principles of Aerial Photography and Satellite Remote Sensing
CO2: Understanding the physics and fundamental concepts of Remote Sensing
CO3: Applying the techniques of digital image processing for feature extraction and mapping
CO4: Analysing and interpreting satellite images for identification of features and events
CO5: Evaluating and modelling scenarios for decision making on resource assessment and planning

MODULE - 1

Introduction to Remote Sensing
Definition; Objectives; Basic principle; Process; Spectral signatures; Platforms; Software; Sensor resolutions; Advantages and limitations; Brief history of remote sensing.
[03]

Physics of Remote Sensing
Physics of remote sensing; Electromagnetic spectrum; Black body concept; Atmospheric windows; Electromagnetic radiation: wave model and particle model, Stephen Boltzmann Law, Wein's Displacement Law; Energy interaction: Scattering - absorption – reflection.
[03]

MODULE - 2

Aerial Photography and Photogrammetry
Basic principles; Photographic systems; Advantage and Disadvantages; Vertical aerial photography; Scale of photography; Relief displacement; Stereoscopy; Vertical exaggeration; Elements of image interpretation.
[06]

MODULE - 3

Satellite Sensors
Imagining systems; Working principle; Geometry of scanners; CCD arrays and platforms; Satellite orbits; History of space imaging; Satellite missions - LANDSAT, SPOT, IRS etc.; Characteristics of sensors: MSS, TM, LISS – I to IV, Outputs from various sensors.
[03]

Image Visualisation
Image geometric distortions; Digital image data formats; Image types; Colour theory, False Colour Composites, Band combinations; Band ratio, NDVI.

[03]

MODULE - 4

Digital Image Processing
Geometric and radiometric corrections of images; Ground Control Points, Root Mean Square Error; Image resampling; Image contrast enhancement; Image filtering, Linear edge detection and enhancement; Principal Component Analysis; Intensity-Hue-Saturation; Image fusion and resolution merge.

[06]

Digital Image Classification
Classification techniques: Parametric, non-parametric, non-metric, hard rule and fuzzy rule based, Supervised and unsupervised, per-pixel and object-oriented classification; Clustering techniques; Accuracy assessment; Linear mixture modelling; ANN based classification; Digital change detection; Change detection techniques; Spectral change vector analysis; Error matrix.

[08]

MODULE - 5

Beyond Optical Remote Sensing
Thermal Infra-Red remote sensing; Heat energy budget; Brightness temperature and Emissivity; Hyperspectral remote sensing; Microwave remote sensing: passive and active sensing; Imagining RADAR, LIDAR and SONAR; Applications.

[08]

Total contact hours: **40**

Textbooks and Reference Books:

1. Paul R Wolf, Elements of Photogrammetry, McGraw Hill.
2. Lillesand and Kiefer, Remote sensing and Image Interpretation, John Wiley and Sons.
3. Ravi R Gupta, Remote Sensing Geology, Springer
4. Floyd F Sabins, Remote Sensing Principles and Interpretation, WH Freeman and Co.
5. John R Jenson, Introductory Digital Image Processing, Prentice Hall.
6. Burrough P A, Principles of Geographical Information System for Land Resource Assessment, Oxford University Press.
7. Bonham-Carter G F, Geographic information systems for geoscientists modelling with GIS (1995), Pergamon.
9. Hall M K, Schaller C J, Walker C S, and Kendal L P, Exploring Water Resources: GIS Investigations for the Earth Sciences (2002), Brooks Cole

(Semester: IV)

CE 206A2/A8 GEOGRAPHIC INFORMATION SYSTEMS [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

CO1: Remembering the basic principles of Geographic Information Systems (GIS)
CO2: Understanding the capabilities, advantages, and limitations of GIS
CO3: Applying the techniques of GIS for spatial mapping
CO4: Analysis the real-world scenarios through integration of remote sensing and GIS
CO5: Modelling scenarios for decision making on resource assessment and planning using GIS

MODULE - 1

Introduction to GIS
Definition; Salient features; History; Components; Elements of GIS; Data types; Measurement scales of attribute data; Why GIS?

[03]

Map projections and Coordinate systems
Map projections; Coordinate systems and geo-referencing; Coordinate transformations; Resampling; Raster and Vector models.

[03]

MODULE - 2

GIS Measurements
GIS measurements: Raster versus Vector; Distance measurements; Proximity analysis.

[03]

Data and Database in GIS
Data structures and models; Continuous versus Discrete data; Database management system; Database structures; Database creation; Data analysis functions.

[03]

MODULE - 3

Spatial Analysis and Mapping
Interpolation techniques; Spatial analysis; Spatial statistics; GIS queries; Reclassification; Digitization; Buffering; Raster GIS filtering; Boolean operations; Map overlay; Site suitability analysis and zoning.

[04]

Terrain Analysis
Terrain Analysis: rater versus vector; Topology concept; DTM and TIN models; Extraction of terrain parameters: slope, aspect, curvature, hill shading, view shed analysis, contouring; volumetric estimation.

[04]

Network Analysis
Definition and concept of network; Client-server Network web GISl; Types of network analysis examples: shortest path problem, travelling salesperson's problem, location-allocation modelling, route tracing; Geocoding; Path analysis.

[04]

MODULE - 4

GIS Modelling
Process modelling in GIS (natural and scale analogue models, conceptual models, mathematical models); multi-criteria evaluation; criteria weighting: rating, ranking, and pair-wise comparison; Analytic Hierarchic Process (AHP); Advanced spatial modelling.

[06]

MODULE - 5

Integrated Remote Sensing and GIS Applications
Geology and Geohazards: geological structures, landforms, topography, rocks. Identification of minerals and ore deposits; Zoning and micro-zoning for landslide, earthquake, avalanche, beach erosion, land subsidence etc.
Hydrological hazards: flood forecasting, flood inundation mapping, flood-risk zoning; reservoir sedimentation; fluvial geomorphology and environmental appraisal, snow melt initiation; drought and water-scarcity; groundwater potential modelling; groundwater quality; aquifer vulnerability; soil moisture.
Urban and regional planning: mapping and monitoring urban growth and changes; land use/land cover mapping; land degradation; deforestation; desertification; basin erosion; sedimentation; hazard and risk assessment, forecasting etc.

[10]

Total contact hours: **40**

Textbooks and Reference Books:

1. Burrough P A, Principles of Geographical Information System for Land Resource Assessment, Oxford University Press.

2. Bonham-Carter G F, Geographic information systems for geoscientists modelling with GIS (1995) Pergamon.

3. Kang-Tsung Chang, Introduction to Geographic Information Systems, 9th Edition, McGraw Hill

4. Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind, Geographic Information Science and Systems. 4th Edition, Wiley

(Semester: V)

CE 303A2/A8 DIGITAL IMAGE PROCESSING [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):

CO1: Remembering the basic principles of Aerial Photography and Satellite Remote Sensing
CO2: Understanding the physics and fundamental concepts of Remote Sensing
CO3: Applying the techniques of digital image processing for feature extraction and mapping
CO4: Analysing and interpreting satellite images for identification of features and events
CO5: Evaluating and modelling scenarios for decision making on resource assessment and planning

MODULE - 1

Remote Sensing and Digital Image Pre-processing
Remote sensing – an overview; Advantages and limitations; Data requirements and resolutions; Processing of digital images.

[04]

Remote Sensing Data Collection
Analogue image digitization; Digital remote sensor data collection; Multiple imagining; Imagining spectrometry; Airborne and satellite-borne digital cameras; Digital image data formats.

[04]

MODULE - 2

Image Quality Assessment and Statistical Evaluation
Overview; Image processing mathematical notation; Sampling theory; The histogram and its significance; Metadata; Pixel values visualisation; Univariate descriptive image statistics; Multivariate image statistics; Feature space plots; Geostatistical analysis; Autocorrelation and kriging.

[04]

Image Display and Visualization
Overview; Image display considerations; Black-and-white hard-copy image display; Image colours and display; Merging of remote sensing data; False Colour Composite; Image Fusion; Dimension measurement in image – length, perimeter, area, shape.

[04]

MODULE - 3

Image Radiometric Correction

Overview; Electromagnetic energy interactions; Conduction, convection, and radiation; Electromagnetic radiation models; Atmospheric energy–matter interactions; Terrain energy–matter interactions; Energy-matter interactions at the sensor system; Correction for remote sensing detector error; Remote sensing atmospheric correction; Correction for slope and aspect effects.

[06]

Geometric Correction

Internal and external geometric error; Types of geometric correction; Ground control points; Image-to-map geometric rectification; RMS error; Mosaicking.

[02]

MODULE - 4

Image Enhancement

Overview; Image reduction and magnification; Transects (spatial profiles); Spectral profiles; Contrast enhancement; Band ratioing; Neighbourhood raster operations; Spatial filtering; Principal components analysis (PCA); Vegetation indices; Texture transformations; Landscape ecology metrics.

[08]

MODULE - 5

Information Extraction Using Imaging Spectroscopy

Overview; Panchromatic, Multispectral and Hyperspectral data collection; Hyperspectral image quality assessment; Radiometric calibration; Geometric correction; Dimensionality reduction; Endmember (Purest pixels) determination; Mapping and matching; Selected indices useful for hyperspectral data analysis; Derivative spectroscopy.

[08]

Total contact hours: **40**

Textbooks and Reference Books:

1. **John R Jenson**, Introductory Digital Image Processing, Prentice Hall
2. **Lillesand and Kiefer**, Remote sensing and Image Interpretation, John Wiley and Sons.
3. Paul Mather, Computer Processing of Remotely sensed Images, 5th Editon, Wiley Blackwell
4. Michael J De Smith, Michael F Goodchild, Paul a Longley, Geospatial Analysis: A Comprehensive Guide, 6th Edition,
5. Andy Mitchell & Lauren Scott Griffin, The Esri Guide: Spatial Measurements and Statistics, 2nd Edition, Esri Press
6. Jensen, J. R., Guptill, S., and D. Cowen, 2012, Change Detection Technology Evaluation, Bethesda: U.S. Bureau of the Census, Task 2007, FY2012 Report.

(Semester: VI)

CE 307A2/A8 PATTERN RECOGNITION [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcome (CO):

CO1: Identifying the elements of image interpretation
CO2: Understanding the basic principles of pattern recognition process
CO3: Applying the techniques of pattern recognition in pixel clustering
CO4: Classifying digital images for feature identification and mapping
CO5: Implementing advanced techniques of image classification at complex situations

MODULE - 1

Elements of Image Interpretation
Introduction: Definition of digital image; Elements of image interpretation; Development of interpretation keys; Image Restoration, Image Reduction and Magnification; Ground Truthing: Ground Truth Collection; Spectral Signature; Data Calibration; Interpretation of target Properties; Training; Verification.
[08]

MODULE - 2

Pattern Recognition
Concept of Pattern Recognition; Multi-spectral pattern recognition; Spectral pattern recognition; Spatial pattern recognition; Temporal pattern recognition; Spectral discrimination; Signature bank.
[06]

Spatial Patterns, Processes and Uncertainty Modelling
Kriging and Spatial Autocorrelation, Points and Pattern Analysis: Nearest Neighbour Analysis, Quadrat Analysis, Poisson Processes, Uncertainty, Spatial resolution induced error, Positional Uncertainty, Attributed Uncertainty, Error Propagation Analysis, Taylor Series Approximation.
[06]

MODULE - 3

Clustering
Basics of Clustering; Clustering criteria, Different distance functions and Similarity / dissimilarity measures; Within cluster distance criterion; K-means algorithm; Single linkage and complete linkage algorithms; MST; K-medoids; DBSCAN; Data sets - Visualization; Unique clustering.

[08]

MODULE - 4

Digital Image Classification

Thematic Image Classification: Parametric and Non-parametric classifiers, Hard and Soft classification, Advantage and disadvantages of different classifiers, Unsupervised classification: ISODATA, RGB, and K-mean classifiers, Supervised classification system: Minimum distance to mean, Parallelepiped, Maximum likelihood, Mahalanobis Distance classifiers; Limitations of standard classifiers; Object based classification; Accuracy assessment: Reference data, Sampling techniques; Error of Commission and Omission; Error matrix; Kappa statistics and Change detection analysis.

[07]

MODULE - 5

Advanced Classification Techniques and Modelling

Advanced Classification Techniques: Hybrid classification; ANN; Spectral mixture analysis; Fuzzy classifiers; Fuzzy C-means Classifier; Soft-computing and Neuro-fuzzy techniques; Structural pattern recognition; Spectral angle mapper; Decision tree; Support vector machine; Real-life examples.

[05]

Total contact hours: **40**

TEXTBOOKS

1. Duda, Hart and Stork, Pattern Classification, Second Edition, Wiley, 2001.
2. S. Theodoridis, K. Koutroumbas, Pattern recognition, Academic Press, 1999.

REFERENCE BOOKS

1. T.M. Mitchell, Machine learning, Mc Graw-Hill, New York, 1997.
2. Joseph, George and Jeganathan, C. (2017). “Fundamentals of Remote Sensing”, 3rd Edition, Universities press (India) Pvt. Ltd., Hyderabad.

(Semester: VII)

CE 403A2/A8 ADVANCED REMOTE SENSING TECHNIQUES
[3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcome (CO):

CO1: Understanding the basic principles of Thermal Remote Sensing
CO2: Realising the principles and concept of Hyperspectral Remote Sensing
CO3: Exploring Microwave Remote Sensing and related advanced technologies
CO4: Analysing the data and information obtained by gravity sensing from space (GRACE)
CO5: Applying the advanced recent UAV Based and underground remote sensing technologies

MODULE 1

Thermal Remote Sensing
Overview, Thermal energy interaction and transfer, Thermal infrared (TIR) radiation principles, Heat energy budget, TIR scanners, TIR missions, Kinetic heat and temperature, Radiant energy and Radiant flux, Emissivity, Factors affecting thermal data, Temperature estimation from LANDSAT data, Applications of thermal remote sensing data.
[06]

MODULE 2

Hyperspectral Remote Sensing
Hyperspectral sensing – an overview; Hyperspectral Data Collection; Dimensionality Reduction; Endmember (Purest Pixels) Determination; Mapping and Matching; Selected Indices Useful for Hyperspectral Data Analysis; Derivative Spectroscopy.
[04]

MODULE 3

Microwave Remote Sensing
Microwave Remote Sensing – an Overview; Passive versus Active Sensing; Active Microwave Sensing – Imagining RADAR; Primary and Secondary Advantages; Applications.
[04]

SAR Interferometry
Introduction to SAR and InSAR; SAR Sensors and Platforms; SAR and InSAR Theory; SAR Image Processing; SAR Interferometry; SAR Polarimetry; SAR Altimetry; DInSAR and PSInSAR; Applications.
[06]

LIDAR and SONAR
LIDAR – an Overview, Working principle, Applications, Advantages.
SONAR – an Overview, Working principle, Applications, Advantages.
[04]

MODULE 4

GRACE
The GRACE mission, Concept and working principle, Data format, variables, and resolution, Sensor models, Real data processing and analysis, GRACE follow-on (GRACE-FO), Groundwater assessments using GRACE and InSAR, Other applications of GRACE.
[06]

MODULE 5

UAV based Remote Sensing
Overview; Working principle; Platforms and Sensors; Advantages and Limitations; Optimal scale and resolution; Operations: pre-flight, during flight, post-flight; Time-series analysis; Errors; Applications; Ethics and Laws.
[06]

Underground Remote Sensing
Underground LiDAR, Fixed LiDAR (GeoLidar) and simultaneous location and mapping (SLAM), Applications in mining.
[04]

Total class hours: **40**

(Semester: VIII)

CE 408A2/A8 ADVANCED GEOSPATIAL MODELLING [3 1 0 4]

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcome (CO):

CO1: Recapitulating the basic principles of geospatial technology
CO2: Learning the techniques of geospatial data management and spatial statistics
CO3: Exploring the technology of real-time analysis through web GIS
CO4: Applying artificial intelligence in GIS for geospatial analysis and mapping
CO5: Modelling, prediction, and forecasting of events based on artificial intelligence

MODULE 1

Geospatial Analysis - Preliminary Concepts
Introduction to Geospatial data, Data Types and sources, Remote Sensing data products and formats, Data analysis tools, Datums, Map projections and Coordinate systems, Understanding maps, Map reading.
[06]

MODULE 2

Geospatial Data and Spatial Statistics
Attribute-based Spatial SQL, Spatial-criteria-based data query, Geodata transformation, Root Mean Square (RMS) Error, Resampling of pixel values, Spatial interpolation methods, Kriging, Spatial autocorrelation, Spatial factor analysis, Spatial regression, Buffering and overlay analysis. DEM and TIN data, their derivatives.
[08]

MODULE 3

Web GIS and Real-time Analysis
Google Earth, Google Earth Engine, GEE editor and cloud computing, GEE-based Time-series and forecasting.
[06]

MODULE 4

Application of Machine Learning, and Deep Learning in Geoinformation
Supervised and unsupervised learning, Logistic learning, Support Vector Machine Learning, Decision tree learning, Ensemble learning, Neural network learning, Data preprocessing and validation, Convolutional neural network.
[06]

MODULE 5

Modelling, Prediction, Forecasting, and Decision Making
Weight of evidence, Analytic Hierarchy Process, Spatial data reclassification, Binary models, Indexed models, Regression models, Logistic Regression Models, Process models, Time-series and Forecasting models, GeoAI-aided models.
[08]

Total class hours: **40**

Textbooks and Reference Books

1. T.M. Mitchell, Machine Learning, Mc Graw-Hill, New York, 1997.
2. Eugene Charniak, Introduction to Deep Learning. The MIT Press, Cambridge, Massachusetts, London, England, 2018.

ENVIRONMENTAL ENGINEERING

(Semester: III)

CE203A2/A8 ENVIRONMENT MANAGEMENT [3 1 0 4]

Course Outcomes:

CO1: This course will introduce students to the various EM system standards.
CO2: Students will understand the concepts and will then take up the issues and techniques relating to EM.
CO3: Students will also discuss environmental design and economics.

NPTEL Link: https://nptel.ac.in/courses/120108004

Module no.	Description	Hours
1	Principles of Environmental Management. Ecosystem Concepts. Environmental Concerns in India. Policy and Legal Aspects of EM. Introduction to Environmental Policies. Environmental Laws and Legislations. Environmental Legislations in India. Environmental Impact Assessment (EIA). Impact Prediction, Evaluation and Mitigation. Forecasting Environmental Changes	**05**
2	Strategic Environmental Assessment (SEA). Environmental Clearance Procedure in India. EIA Documentation and Processes. EIA Monitoring and Auditing. Environmental Auditing. Elements of Audit Process. Waste Audits and Pollution Prevention Assessments. EA in Industrial Projects. Liability Audits and Site Assessment. Auditing of EM	**12**
3	Life Cycle Assessment (LCA). Stages in LCA of a Product. Procedures for LCA. Different Applications of LCA. Environmental Management System Standards. EMS Standards: ISO 14000. Implementation of EMS Conforming to ISO 14001. Environmental management techniques. Application of Remote Sensing and GIS in EM	**08**

4	Ecosystem approach to risk assessment. Environmental Design (ED) ED for Manufactured Products. ED for Buildings. ED for Developmental Planning. Environmental Economics. Economics and the Environment. Environmental Valuation. Economics of Natural Resources. Environmental and Regional Economics. Ecological Economics.	**12**
	Total	**38**

References:

1. Vijay Kulkarni and Ramachandra T.V., 2006. Environmental Management,
2. Commonwealth Of Learning, Canada and Indian Institute of Science, Bangalore.

(Semester: IV)

CE 207A2/A8 SOLID WASTE MANAGEMENT [3 1 0 4]

Course Outcomes:

CO1: Students will understand the functional element of solid waste management which is important because it helps in evaluating the impacts of projected changes and technological developments

CO2: Students will understand generation, collection and transportation of MSW.

CO3: Students will have in depth understanding about various treatment methods

CO4: Students will have an insight into various legislation in the area of MSW.

Module no.	Description	Hours
1	1. Evolution of Solid Waste Management 2. Sources/Types and Characteristics of Solid Waste 3. Generation of Solid Waste	7
2	1. Waste Handling, Separation, storage, and Processing 2. Collection of Solid Waste 3. Transfer and Transport	**15**
4	1. Separation and processing of Solid Waste 2. Chemical Transformation (combustion/incineration) 3. Biological Treatment (Composting)	**8**
5	1. Biological Treatment (Anaerobic Digestion) 2. Disposal of Solid Waste 3. ISWM and legislation	**10**
	TOTAL	**38**

References:

• Christensen, H. T., Solid Waste Technology & Management, Wiley, 2010, Volume 1 & 2

• Haug, T. R., The Practical Handbook of COMPOST ENGINEERING, Lewis Publishers, 1993

• Reinhart, R. D. and Townsend, G. T., Landfill Bioreactor Design & Operation, CRC Press, 1997, 1st Edition

• Tchobanoglous, G. and Kreith, F., HANDBOOK OF SOLID WASTE MANAGEMENT, McGraw Hill, 2002, 2nd Edition

• Tchobanoglous, G., Theisen and Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill, 1993.

(Semester: V)

CE 304A2/A8 AIR POLLUTION AND CONTROL
[3 1 0 4]

Course Outcomes:

CO1: Students who take this course will gain a thorough, critical understanding of air pollution and various mechanism and concepts

CO2: Students will gain a detailed understanding of Air pollution control devices.

CO3: Students will gain a detailed understanding of Air pollution standards, laws and understanding of emerging technologies.

Module no.	Description	Hours
1	**1** : Air Pollution: Introduction and Impacts of air pollution on human health, vegetation, animals, building materials, structures, and atmosphere, soil and water bodies. **2 :** Sources, classification and formation/transformation of air pollutants: Meteorology and Atmospheric Stability. **3** : Lapse Rate, Plume Behaviour, and Air Quality Monitoring, Air Quality Index (AQI)	**10**
2	**1** : Air Quality Modelling, Gaussian dispersion models: point, line and area source models **2**: Emissions Inventory: Transport, Industrial, Agricultural, Residential and Commercial sectors	**09**
3	1: Indoor air pollution: sources, types and health impacts. Sampling, assessment and evaluation of Indoor air quality. **2 :** Global and regional environmental issues of air pollution: Ozone depletion, Climate change, Global warming, Acid rain. **3** : Air pollution control devices, equipment and their design.	**12**
4	**1** : Air pollution emission standards, National and international policies, acts, rules and regulations. **2** : Emerging technologies and strategies to mitigate air pollution, Current challenges and way forward. **3** : Lab-based measurements of air pollutants.	**09**
	Total	**40**

References:

1. Wark, K., Warner, C.F., and Davis, W.T., "Air Pollution: Its Origin and Control", Addison Wesley Longman. 1998.
2. Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C., "Fundamentals of Air Pollution", Academic Press. 2005.
3. Seinfeld, J.H., Pandis, S.N., "Atmospheric Chemistry and Physics", John Wiley. 2006.
4. Lodge, J.P. (Ed.), "Methods of Air Sampling and Analysis", CRC Press. 1988.
5. Gurjar, B.R., Molina, L., Ojha, C.S.P. (Eds.), "Air Pollution: Health and Environmental Impacts", CRC Press. 2010.

(Semester: VI)

CE 308A2/A8 HAZARDOUS WASTE MANAGEMENT [3 1 0 4]

Course Outcomes:

CO1: This course provides an in depth understanding of solid and hazardous waste characteristics and management..

CO2: Students will gain a detailed knowledge, Hazardous waste Characterization Environmental legislation for solid and hazardous waste disposal and transport Risk Assessment.

CO3: Students will gain a detailed understanding of Waste stabilization techniques, Chemical, physical and biological treatment Landfill design for Sanitary and Hazardous Wastes.

NPTEL Course : https://archive.nptel.ac.in/courses/105/106/105106056/#

Module no.	Description	Hours
1	Relevant Regulations Municipal solid waste (management and handling) rules; hazardous waste (management and handling) rules; biomedical waste handling rules; flyash rules;recycled plastics usage rules; batteries (management and handling) rules	04
2	Hazardous Waste Management – Fundamentals Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects	10
3	Radioactive Waste Management – Fundamentals Sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options	04
4	Environmental Risk Assessment Defining risk and environmental risk; methods of risk assessment; case studies Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation	06
5	Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation Landfill design Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration	14
	Total	**38**

References:

1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. 2. LaGrega, M.D.Buckingham,P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994.
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997

(Semester: VII)

CE 404A2/A8 ENVIRONMENTAL IMPACT ASSESSMENT [3 1 0 4]

Course Outcomes:

CO1: An understanding of EIA tool so as to assess the positive and negative environmental, economic and social impacts of a project

CO2: In this course students will develop basic understanding of the history, need, structure, process, involved methods and challenges.

CO3: Students will also learn criteria for selecting method for impact assessment, overview of methods, parameters for public participation ad technique for writing reports.

NPTEL Link: https://archive.nptel.ac.in/courses/124/107/124107160/

Module no.	Description	Hours
1	1: Introduction to Environment Management & EIA 2: Legal, Policy & Regulatory Framework 3: EIA Procedure - Scoping & Screening and Establishing Baseline Conditions	05
2	1: EIA Methodologies 2: Connectedness: connected spaces and subspaces, Connectedness of the real line, Intermediate value theorem 3. EIA Methods, Tools and Techniques	12
3	1: Public Involvement in EIA 2.: Impact Management - Mitigation & Preparation of Environment Management Plans (EMP) 3.: EIA Reporting & Review of EIA Quality	10
4	1: Decision Making & Project Management 2: Implementation & Follow up 3: EIA Case Examples	12
	Total	40

References:

1) Wathern P., “Environmental Impact Assessment: Theory and Practice”,Routledge Publishers,1990

2) Marriott B., “Environmental Impact Assessment: A Practical Guide”,McGraw-Hill Publication,1997

3) Shrivastava A.K., Baxter Nicola, Grimm Jacob, “Environmental Impact Assessment”, APH Publishers, 2003

4) Anjaneyulu Y., Manickam Valli, “Environmental Impact Assessment Methodologies”, CRC Press 2011

5) Glasson J., Therivel Riki, Chadwick Andrew, “Introduction to Environmental Impact Assessment”, Oxford Brookes University 2012/ 4th edition

(Semester: VIII)

CE 408A2/A8 SUSTAINABLE ENGINEERING CONCEPTS AND LIFE CYCLE ANALYSIS [3 1 0 4]

Course Outcomes:

CO1: This course will introduce students to the fundamental concepts related to interaction of industrial and environmental/ecological systems, sustainability challenges facing the current generation, and systems-based approaches required to create sustainable solutions for society.

CO2: Students will understand the concepts and the scientific method as it applies to a systems-based, trans-disciplinary approach to sustainability, and will be prepared to identify problems in sustainability and formulate appropriate solutions based on scientific research, applied science, social and economic issues.

CO3: Students will also learn about the basic concepts of life cycle assessment (LCA), along with life cycle inventory (LCI) and life cycle impact assessment (LCIA) including the social and economic dimensions.

NPTEL Link: https://archive.nptel.ac.in/courses/105/105/105105157/

Module no.	Description	Hours
1	An Introduction to Sustainability Concepts and Life Cycle Analysis (Introduction, Material flow and waste management, What it all means for an engineer? Water energy and food nexus) Risk and Life Cycle Framework for Sustainability (Introduction, Risk, Environmental Risk Assess-ment, Example Chemicals and Health Effects, Character of Environmental Problems)	05
2	Environmental Data Collection and LCA Methodology (Environmental Data Collection Issues, Sta-tistical Analysis of Environmental Data, Common Analytical Instruments, Overview of LCA Methodology - Goal Definition, Life Cycle Inventory, Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Software tools) Life Cycle Assessment – Detailed Methodology and ISO Framework (Detailed Example on LCA Comparisons, LCA Benefits and Drawbacks, Historical Development and LCA Steps from ISO Framework)	12

3	Life Cycle Inventory and Impact Assessments (Unit Processes and System Boundary Data Qual-ity, Procedure for Life Cycle Impact Assessment, LCIA in Practice with Examples, Interpretation of LCIA Results) Factors for Good LCA Study (ISO Terminologies, LCA Steps Recap, Chemical Release and Fate and Transport, and Green Sustainable Materials)	**08**
4	Design for Sustainability (Environmental Design for Sustainability: Economic, Environmental Indicators, Social Performance Indicators, Sustainable Engineering Design Principles and Environmental Cost Analysis) Case Studies (e.g., Odour Removal for Organics Treatment Plant, Comparison of Hand Drying Methods, Biofuels for Transportation, Kerosene Lamp vs. Solar Lamp, Bioplastic etc.).	**12**
	Total	**38**

References:

Allen, D., & Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.

CHOICE BASED ELECIVES

Prof. (Dr.) Chandrashekhar Bhuiyan
(Professor & Head)

Mr. Sajal Sarkar
(Assistant Professor –SG)

Mr. Guru Prasad Sharma
(Assistant Professor –SG)

CE 409A2 ACCOUNTING AND FINANCE FOR ENGINEERS
[3 0 0 3]

(Choice Based Elective)

SCHEME OF EXAMINATION
Questions to be set: 05 (All Compulsory)

Course Outcomes (CO):
After completion of this course, students should be able
1. To understand the basic accounting concepts and finance.
2. To understand the system of accounting and record keeping.
3. Students will be able to analyse the financial statements.
4. To understand the importance of financial planning and budgeting.
5. To understand the fundamentals of different parameters of budgeting.

Module 1:

Basic Accounting and concepts in finance; Book keeping: definitions, objectives, elements, journal and ledger. Accounting & Concepts in Finance I: definitions, objectives, characteristics, limitations, basic terms; GAAP (Generally Accepted Accounting Principles)

Module 2:

Accounting & Concepts in Finance II: Systems of accounting, cash book, bank book, depreciation; provisions, reserves, accounting equation, journal & ledger entries, trial balance, profit & loss; account,balance sheet, cash flow statement).

Module 3:

Analysis of financial statements I: Financial leverage, financial ratios. Analysis of financial statements II: Significance and applications.

Module 4:

Financial planning including capital budgeting I: Definition, financial planning options and objectives, time value of money, Financial planning including capital budgeting II: simple and compound interest, rule of 72, methods of capital budgeting - payback period.

Module 5:

Financial planning including capital budgeting III: Accounting rate of return (ARR), net present value (NPV), internal rate of return (IRR).

References:

1. Introduction To Accounting And Finance For Civil Engineers, Prof. K. N. Jha, Prof. Sudhir Misra, Civil Engineering. IIT Kanpur.
2. Estimation and Costing in Civil Engineering, B. N. Dutta
3. Contracts and Accounts, Mukesh N. Gangjlade.

CE 410A2 SAFETY IN CONSTRUCTION [3 0 0 3]

(Choice Based Elective)

COURSE OUTCOMES (CO):

1. To learn about various terminologies associated with safety and injuries.
2. This course aims to make the students well-versed with the latest safety and health regulations.
3. To understand various Indian Standards guidelines applicable to the construction industry.
4. Students will be able to assess and analyse the hazardous construction project sites.
5. At the end of this course, the students will be able to plan, and manage the hazardous construction project sites.

Module 1: Introduction

Basic terminology in safety, types of injuries, safety pyramid, Role of stakeholders in Construction. [07]

Module 2: Construction safety

Cost of injury vs investment in safety, Accident patterns, theories of accident-causation, Safety program accident, PPE in construction, Case study on construction safety, Fall hazard in concreting and demolition work, Planning for safety budget, safety culture. [10]

Module 3: Site safety programs

Introduction to OSHA regulations; Role of stakeholders in safety, Excavation, trench and tunneling safety, Crane safety, case study. Site safety programs - Job hazard analysis, accident investigation & accident indices-violation, penalty. [08]

Module 4: Safety during construction, alteration, demolition works

Safety during construction, alteration, demolition works - Earthwork, steel construction, temporary structures, masonry & concrete construction, cutting & welding. [07]

Module 5: Construction equipment and other hazards

SoPs (Safe Operating Procedures) - Construction equipment, materials handling-disposal & hand tools, other hazards - fire, confined spaces, electrical safety, BIM for safety. [08]

Total contact hours: **40**

References

1. **Safety in Construction** (NPTEL course) by Prof. J. Uma Maheswari. https://archive.nptel.ac.in/courses/105/102/105102206/
2. **Construction Safety** by R.K Mishra
3. **Electrical Safety, Fire Safety Engineering and Safety Management** by Rao, Jain and Saluja.
4. **Safety Fundamentals and Best Practices in Construction Industry** by Pedro P. Marfa.

Prof. (Dr.) Chandrashekhar Bhuiyan
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Dr. Sajal Sarkar
(Assistant Professor –SG)

Mr. Guru Prasad Sharma
(Assistant Professor –SG)