Teaching and Examination Syllabus of Bachelor of Technology (2nd Year) in Civil Engineering

(As per NEP-2023)

Department of Civil Engineering

Sardar Vallabhbhai National Institute of Technology, Surat

Sr. No.	Subject	Code	Scheme L-T-P	Credits (Min.)	Notional hours of Learning (Approx.)
	Third Semester (2nd year of UG)				
1	Hydraulic Engineering	CE201	3-1-2	5	100
2	Environmental Engineering	CE203	3-1-2	5	100
3	Building Planning	CE205	3-1-2	5	100
4	Soil Mechanics	CE207	3-1-2	5	100
5	Elective 1	CE2AA	3-X-X	3/4	55/70
			Total	**23-24**	**455-485**
	Fourth Semester (2nd year of UG)				
1	Concrete Technology (*)	CE202	3-0-2	4	85
2	Highway Materials and Construction	CE204	3-0-2	4	85
3	Surveying-II	CE206	3-1-2	5	100
4	Elementary Structural Mechanics	CE208	3-0-2	4	85
5	Elective 2	CE2BB	3-X-X	3/4	55/70
			Total	**20-21**	**410-440**
6	Minor / Honor(M/H#1)	CE2CC	3-X-X	3/4	55/70/85
7	Vocational Training / Professional Experience (Optional) (Mandatory for Exit)	CEV04/ CEP04	0-0-10	5	200 (20x10)

Electives Baskets

Sr. No.	Subject (L – T – P : 3 – X – X)	Scheme L-T- P	Credits	Code
	Third Semester (Elective-1)			
1	Environmental Management	3-0-0	3	CE231
2	Engineering Geology	3-0-0	3	CE233
3	Airport Planning	3-1-0	4	CE235
4	Integrated Watershed Management	3-1-0	4	CE237
5	Professional Ethics, Economics and Business Management			MA239
	Fourth Semester (Elective-2)			
1	Advanced Construction Technology	3-1-0	4	CE232
2	Building Maintenance	3-0-0	3	CE234
3	Advanced Water and Wastewater Treatment	3-0-0	3	CE236
5	Environmental Geo-technology	3-0-0	3	CE242
6	Rock Mechanics	3-0-0	3	CE244
7	Pavement Construction and Evaluation	3-0-0	3	CE246
8	Railway Engineering	3-1-0	4	CE248
9	Traffic Engineering and Management	3-0-0	3	CE252
10	Town Planning	3-0-0	3	CE254
11	Sustainable Building Planning	3-0-0	3	CE256
12	Regional Planning	3-0-0	3	CE258
13	Channel Hydraulics	3-0-0	3	CE262
14	Optimization Methods			EE264

Third Semester (2nd year of UG) (Subjects)

CE 201 Hydraulic Engineering

L	T	P	C
3	1	2	5

1. Course Outcomes (COs)

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

CO1	Apply linear momentum and energy equation in fluid flow problems
CO2	Analyse laminar and turbulent flows through close conduits
CO3	Analyze the growth of Boundary layer over flat plate
CO4	Compute and analyse flow in open conduit
CO5	Analyse the flow through pumps and turbines

2. Syllabus

- **FLUIDS PROPERTIES AND HYDROSTATICS (08 Hours)**
  Fluid continuum, fluid properties, hydrostatic forces on plain and curved surfaces, stability of floating and submerged bodies, pressure measurements..

- **FLUID KINEMATICS AND DYNAMICS (08 Hours)**
  Concept of fluid particles, stream lines, path lines, differential forms of continuity equation, stream function, translation, deformation, rotation, circulation and vorticity of fluid elements, , stream function, potential function, flow net, acceleration of fluid elements; System and control volume. Steady linear momentum equation, Euler's equation for one-dimensional flow, Bernoulli's equation including its applications for fluid flow problems.

- **BOUNDARY LAYER THEORY (03 Hours)**
  Concept and thickness of laminar and turbulent boundary layers over flat plates, boundary layer separation and their control.

- **LAMINAR AND TURBULENT FLOWS (08 Hours)**
  Reynolds experiments, Reynolds number and classification of laminar, transition and turbulent flows, flow development in laminar and turbulent flows, shear stress distribution, Hagen Poiseuille's equation, Coquette flow; characteristics of turbulent flows, Reynolds shear stresses, Prandtl's mixing length theory, velocity distributions in closed conduit flows with hydro dynamically smooth and turbulent flows, friction factor.

- **APPLICATION OF FLUID FLOWS THROUGH PIPES (04 Hours)**

Major and minor head losses, pipes in series and parallel, pipes with equivalent diameter and length, Total energy and hydraulic gradient lines, analysis of water distribution network.

- **DIMENSIONAL ANALYSIS (02 Hours)**
  Development of functional relationships for fluid flows, pertinent and superfluous variables, Physical model laws, scale effect, distorted and undistorted models.

- **FLOWS AND CONCEPT OF SPECIFIC ENERGY IN OPEN CONDUITS (08 Hours)**
  Classification of open conduits flows, velocity and pressure distributions, applications of energy and momentum equations in open channels, development of uniform flows, resistance law, efficient channel section, section factors, specific energy and depth-discharge diagrams, critical flow, hydraulic jump.

- **INTRODUCTION TO PUPMS (04 Hours)**
  Classification of pumps, working principles and components of centrifugal pumps, velocity vector diagram and work done by centrifugal pumps, single and multistage pumps, Pumps in parallel and series, efficiency of pumps, operating characteristics of centrifugal pump.

(Total Lectures: 45 hours)

3. Practical

1. Determination of metacentric height.
2. Estimation of hydraulic coefficients for orifice.
3. Calibration of rectangular and triangular notches.
4. Calibration of Venturi meter and orifice meter.
5. Verification of Bernoulli's principle.
6. Friction factors for laminar and turbulent flows for single and multiple pipes.
7. Characteristics of Forced and free vortex.
8. Measurement of velocity distribution using Pitot tube and Current meter.
9. Development of specific energy diagram.
10. Characteristics of Hydraulic jump.
11. Operating characteristics of centrifugal pumps.

4. Books Recommended

1. W R Fox and A T McDonald, Introduction to Fluid Mechanics, Wiley and Sons Inc., New York, 1998.
2. A K Jain, Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2000.
3. K G Ranga Raju, Flow through Open channel, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 1997.
4. K Subramanya, Flow in Open Channels, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 1998.
5. F M. White, Fluid Mechanics, The McGraw Hill Companies, New York,2008.

5. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	1	1	1
CO3	1	1	1
CO4	1	1	1
CO5	1	1	1

-Not related 1-Low 2-Moderate 3-High

CE 203 Environmental Engineering

L	T	P	C
3	1	2	5

1. Course Outcomes (COs)

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

CO1	Analyze water quality and quantity requirements for given uses
CO2	Summarize the physical, chemical and biological characteristics of wastewater
CO3	Design water treatment plant based on the source water quality
CO4	Differentiate amongst various unit operations and processes for municipal wastewater treatment with design applications
CO5	Analyze different wastewater disposal options available

2. Syllabus

- **QUALITY AND QUANTITY OF WATER (08 Hours)**
  Water quality parameters – physical, chemical and microbiological, principles of their analysis. Drinking water quality standards. Water demand – types of demand, variation in demand, population forecast. Sources of water - Intake structures.

- **WATER TREATMENT (10 Hours)**
  Need for water treatment. Process details and design considerations of treatment units such as aeration, sedimentation, coagulation and flocculation, filtration, disinfection, and water softening.

- **WATER DISTRIBUTION SYSTEMS (04 Hours)**
  Pumps and pumping stations. Pipes, Pipe appurtenances. Testing of water main - Distribution reservoirs - Distribution methods – Introduction to pipe network analysis - Planning of water supply project.

- **MUNICIPAL WASTEWATER QUANTITY AND CHARACTERISTICS (08 Hours)**
  Wastewater Quantity - Classification of wastewater - Sewerage system for domestic wastewater and storm water - Collections, and appurtenances - Design and layout of sewerage systems - Maintenance of sewerage systems - Physical, Chemical & Biological characteristics and their significance. .

- **TREATMENT OF MUNICIPAL WASTEWATER (04 Hours)**
  Objectives of Wastewater treatment- Treatment methods: Unit Operations and Processes Design criteria - Design of primary treatment System. Concepts of aerobic and anaerobic

Biological treatment and removal mechanism, Design of various biological systems. Importance of nutrient removal, Sludge treatment methods.

- **WASTEWATER DISPOSAL (05 Hours)**
  Principal plane – Principal stress – Tangential and normal stress – Derivation of Major and Minor principal stresses for different cases – Mohr's circle graphical method

(Total Lectures: 45 hours)

3. Practical

1. Water/wastewater quality: Determination of Turbidity, pH, alkalinity
2. Water quality: Hardness
3. Water quality: Fluoride
4. Water quality: Chlorides
5. Determination of Chlorine Demand and Chlorine Residual.
6. Determination of optimum coagulant dosage
7. Water quality: Bacteriological analysis of water.
8. Water and wastewater quality: Different types of solids
9. Water and wastewater quality: Sulphates and Phosphates
10. Wastewater: Chemical oxygen demand
11. Wastewater: Biochemical oxygen demand

4. Books Recommended

1. M L Davis, Water and Wastewater Engineering, McGraw-Hill, 2010.
2. Manual on Water Supply & Treatment 3rd Ed. Central Public Health & Environmental Engg. Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1999.
3. G L Karia, R A Christian and N D Jariwala "Wastewater Treatment Concepts & Design Approach", PrenticeHall of India Pvt. Ltd., New Delhi, 2023.
4. Manual on Sewerage and Sewage Treatment, CPH and EE Organisation, Ministry of works and housing Govt. of India, New Delhi, 1991.
5. T J McGhee, "Water Supply & Sewerage", McGraw Hill International Edition, New Delhi,1991.

5. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3	3	2	3	3	2	2	2	2	2
CO2	2	2	2	2	3	2	2	2	2	1	1	1
CO3	3	3	2	3	3	2	2	2	1	2	2	2
CO4	3	3	2	3	3	2	2	2	1	1	1	1
CO5	2	1	1	2	1	1	0	1	0	0	1	1

-Not related 1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	3	2
CO2	3	3	2
CO3	3	2	3
CO4	3	3	1
CO5	2	2	2

-Not related 1-Low 2-Moderate 3-High

CE205 Building Planning

L	T	P	C
3	1	2	5

1. Course Outcomes (COs)

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

CO1	Comprehend the provisions of building bye-laws, National Building Code and relevant acts, guidelines, codes in respect of building planning.
CO2	Understand, interpret and prepare working drawings, foundation plans and perspective drawing
CO3	Plan buildings and prepare approval drawings.
CO4	Apply the knowledge of Building Planning in Infrastructure planning as civil engineer.
CO5	Design and plan residential areas considering socio-economic factors.

2. Syllabus

- **BUILDING SYSTEMS** **(06 Hours)**
  Introduction to buildings, Classification of buildings, Factors affecting site selection and Housing Location choice, Passive Planning.
- **PLANNING APPROACH** **(12 Hours)**
  Building by–laws as per National Building Code and as per local authority, Overview of URDPFI and RERA, Process of planning, Family requirements and analysis, Conceptual plan using bubble and line outlines, Residential building forms. Role of Different stockholders in Planning.
- **BUILDINGS PLANNING:** **(14 Hours)**
  Principles of building planning, significance of sun diagram, wind diagram, orientation, factors affecting, and criteria under Indian condition, Approach of activity analysis for Residential and public buildings, Plan preparation for residential and Public building. Elements of human scale, Size and dimension decisions, Furniture layouts.
- **ARCHITECTURAL COMPOSITION:** **(04 Hours)**
  Mass Composition, Principles of elevation development-techniques, Impacts of colour and structure character, landscaping.
- **BUILDING DRAWINGS** **(09 Hours)**
  Overview of Working and approval drawings, overview of Plan permission process and ODPS, One and two Perspective drawings, building service drawings and Fundamentals of electrical and plumbing layouts, Building drawing software applications.

(Total Lectures: 45 hours)

3. Tutorials

1. Comprehending the Technical terms
2. Study of Building bye-laws and National Building Code
3. Study of model house and comprehend the planning parameters adopted.
4. Study of planning parameters
5. Analyzing approved plan of building.
6. Sketching of Sub- units of Residential and Public Building
7. Understand and planning of Building services

4. Practical

1. Sketching of own residential building.
2. Study of typical building plan of given building.
3. Planning and design of residential buildings.
4. Planning and design of public buildings.
5. Planning and design of circulation space.
6. Planning and design of Building services and Landscape.

5. Books Recommended

1. M Modak N.V. and V.N. Ambdekar, "Town and Country Planning and Housing", Orient Longman Ltd., New Delhi. (1995)
2. Hiraskar G.K. "Fundamentals of Town Planning", Dhanpat Rai & Sons, Delhi (1993).
3. M G Shah, C M Kale and S Y Patki, Building Drawing: With an Integrated Approach to Built Environment, Tata McGraw-Hill Education, New Dehi, 2002.
4. S M Patil, Building Services, Sachin Printers, Mumbai, 2004.
5. Y S Sane, Planning and Designing of Building, Allies Book Stall, Poona, 1990.

6. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

7. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	2	2	2
CO3	3	3	3
CO4	3	3	3
CO5	2	1	1

-Not related 1-Low 2-Moderate 3-High

CE 207 Soil Mechanics

L	T	P	C
3	1	2	5

1. Course Outcomes (COs)

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

CO1	Classify and identify soils and their engineering properties
CO2	Interpret the laboratory and field-testing results
CO3	Evaluate the permeability, seepage, and compaction characteristics of soil
CO4	Apply the knowledge of effective stress, stress distribution and consolidation to determine settlement of soil
CO5	Analyse the shear strength parameters of various types of soil and load carrying capacity of shallow and deep foundation.

2. Syllabus

- **INTRODUCTION (01 Hours)**
  Need for Soil Engineering Studies- Soil as an Engineering Material -Scope of Geotechnical Engineering.

- **BASIC PROPERTIES OF SOIL (04 Hours)**
  Elementary properties and their measurements - Constituents of soil - Phase diagram – Definitions of varies parameters and their Interrelationship – In-situ determination of density.

- **SOIL CLASSIFICATION, CONSISTENCY LIMITS & CLAY MINERALOGY (05 Hours)**
  Grain size analysis-Hydrometer method, Particle size distribution curve - Relative Density- Soil consistency limits - Soil indices –IS Classification of soil - Clay Mineralogy.

- **COMPACTION (03 Hours)**
  Definition - objectives - Laboratory tests- Zero air void Line -Factors affecting compaction- Effect of compaction on properties of soil - Field compaction control - Relative compaction.

- **PERMEABILITY AND SEEPAGE (04 Hours)**
  Permeability - Darcy's law - Laboratory tests - Field tests - Permeability of stratified deposits– Laplace's equation - Seepage – Flow net.

- **EFFECTIVE STRESS ANALYSIS** **(04 Hours)**

  Effective stress principle- Effect of water table fluctuation on effective stress-Effective stress in soil mass due to hydrostatic conditions, capillary action, and steady seepage conditions-Effect of surcharge on effective stress Quick sand condition.

- **CONSOLIDATION** **(05 Hours)**

  Significance of Consolidation - Initial, primary and secondary consolidation - Spring analogy for primary consolidation- Consolidation test- Various parameters - Terzaghi's theory of one-dimensional consolidation - Coefficient of consolidation – Pre consolidation pressure – Secondary consolidation-Field consolidation curve.

- **SHEAR STRENGTH** **(05 Hours)**

  Shear parameters –Mohr-Coulomb's Failure Criterion – Various laboratory tests and their merits & demerits - Drainage conditions- Modified failure envelop– Pore Pressure Parameters.

- **SOIL EXPLORATION** **(02 Hours)**

  Objectives and methods of explorations-Sampling and its design features, SPT, Cone penetration test and in-situ vane shear test.

- **BEARING CAPACITY OF SOIL** **(08 Hours)**

  Introduction – Basic definitions – Bearing capacity theories – Types of shear failure – Effect of water table – Bearing capacity from field tests - plate load test; Introduction to deep foundations – Necessity of pile foundation – Classification of piles – Load carrying capacity of piles.

(Total Lectures: 45 hours)

3. Practical

1. Determination of moisture content, Specific gravity, In-situ density- Core cutter method, Sand replacement method.
2. Sieve Analysis
3. Hydrometer analysis
4. Consistency limits of soil
5. Compaction test on soil
6. Determination of coefficient of permeability of soil
7. Estimation of shear strength of non-cohesive soil by direct shear test.
8. Estimation of shear strength of cohesive by Vane shear test and Unconfined Compressive tests.
9. Computation of consolidation parameters
10. Demonstration of Triaxial shear test
11. Site Visit and Interaction with the practitioners in Geotechnical Engineering.

4. Books Recommended

1. K R Arora, Soil Mechanics and Foundation Engineering, Standard Publishers Distributors, Nai Sarak, Delhi, 2008.
2. J E Bowles, Foundation Analysis and Design, McGraw-Hill Education, New Delhi, 1996.
3. B M Das, & K Sobhan, Principles of Geotechnical Engineering, Cengage Learning, Boston, 2018.
4. D P Coduto, M R Yeung, & W A Kitch, Geotechnical Engineering: Principles and Practices, 2nd Ed, Pearson Education, USA, 2017.
5. M Datta, & S Gulati, Geotechnical Engineering, McGraw-Hill Education, New Delhi, 2017.

5. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	3	3	3
CO3	2	2	3
CO4	2	2	2
CO5	2	2	2

-Not related 1-Low 2-Moderate 3-High

CORE ELECTIVE/ ELECTIVE 1

3rd Semester- 2nd Year UG

CE 231 Environmental Management

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Study of local and global environmental impact issues like water pollution, air pollution, noise pollution, global warming.
CO2	Explain important Indian and global environmental protection acts and protocols.
CO3	Introduction to EIA, Environmental Audit and ISO:14001 and their methodologies.
CO4	Study of different national environmental policy and guidelines.
CO5	

2. Syllabus

- **ENVIRONMENT & POLLUTION CONTROL (09 Hours)**
  Environment and ecology; Causes, effects and control measures for various types of pollution like air, water, land, noise; Global Warming, Climate Change, Green House Gas Effect, Acid Rains, Ozone Layer Depletion.

- **ENVIRONMENTAL MANAGEMENT & POLICY (09 Hours)**
  Sustainability and sustainable development; Environmental management plan; Disaster management; Environmental Audit; Life cycle assessment; National environmental policy; Beyond environmentalism and sustainability issues.

- **ENVIRONMENTAL IMPACT ASSESSMENT (12 Hours)**
  Significant impacts of human activities / large projects; Evolution of EIA; EIA at project; regional and policy levels; Environmental clearance procedure in India; Rapid and Comprehensive EIA; significance of public participation / hearing in EIA; Post project monitoring; Resettlement and rehabilitation issues. EIA case studies / histories for different types of projects.

- **INDIAN ENVIRONMENTAL STANDARDS AND LEGISLATION (09 Hours)**
  Significance of environmental standards, Various environmental standards such as water, waste water discharge, air emission, ambient air quality, noise etc; Significance and importance of legislation for environmental protection; Role of government, non-government organizations and citizens; Hierarchal structure of Governmental pollution control organizations in India; Important Indian environmental legislation and acts.

- **GLOBAL ENVIRONMENTAL STANDARDS (03 Hours)**
  ISO 14000 introduction – General description of ISO 14001 – Environment Management System (EMS) – Key elements of ISO 14001 and EMS.

(Total Lectures: 42 hours)

3. Books Recommended

1. Gilbert M. Masters and Wendell P. Ela, "Introduction to Environmental Engineering and Science", Third Edition, Pearson Prentice Hall Inc., 2008.
2. Howard S Peavy and George Tchobanoglous, "Environmental Engineering", McGraw Hill Co, New Delhi, 2004.
3. Larry W. Canter, "Environmental Impact Assessment", Tata McGraw Hill Co, Singapore, 1996.
4. Kailash Thakur, "Environmental protection law and policy in India", Deep and Deep publishers, New Delhi, 1997.

4. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1			
CO2			
CO3			
CO4			
CO5			

-Not related 1-Low 2-Moderate 3-High

CE 233 Engineering Geology

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Understand the fundamental principles and processes in geology
CO2	Identify different type of rocks, their formation and mineral composition
CO3	Analyze the effect of different structural features on the design of civil engineering structures
CO4	Analyze geological data by using DIPS software and its applications
CO5	Design the structures under the given geological conditions

2. Syllabus

- **INTRODUCTION (10 Hours)**
  General geology, Earth and Earth processes, Origin, Interior and age determination of Earth, Physical geology, Mineralogy, Petrology. Study of Igneous, Sedimentary, and Metamorphic rocks, Silicate structures, Symmetry elements, Mineral characteristics, and Families of minerals.

- **PROCESSES IN GEOLOGY (11 Hours)**
  Igneous processes, Bowen's reaction principle, textures and structures of plutonic and volcanic rocks, Weathering processes, Sedimentary processes, Structures of sedimentary rocks, Effects of pressure and temperature, Metamorphic rocks and structures, Geological work of Rivers, Sea/Oceans, Glaciers, Wind and Deposits.

- **STRUCTURAL GEOLOGY (15 Hours)**
  Structural features, Beds, Folds, Joints, Faults, and their Influence on Civil structures, Rockmass description, Plate tectonics and Sea floor spreading, Continental drift, Mechanical behavior of soils and rocks, Principles of stratigraphy, Standard stratigraphic Time Scale, Indian stratigraphy, Distribution of various economic minerals, their composition and mode of occurrence.

- **SITE INVESTIGATION (09 Hours)**
  Geophysical Methods: Resistivity and Seismic Refraction methods, Earthquakes, Landslides, Subsidence, Erosion, Karst formations, Engineering properties of Rocks, Site selection for Slopes, Tunnels and Foundations, Rock as a construction material.

(Total Lectures: 45 hours)

3. Books Recommended

1. L G de Vallejo, & M Ferrer, Geological Engineering, CRC Press, Balkema, 2011.
2. M P Billings, Structural Geology, 4th Edition, Pearson India, New Delhi, 2016.
3. F G Bell, Fundamentals of Engineering Geology, Butterworth-Heinemann, Oxford, 2016.
4. S Gangopadhyay, Engineering Geology, Oxford University Press, New Delhi, 2013.
5. A C Mclean, & C D Gribble, Geology for Civil Engineers, 2nd Edition, E. & F. N. Spon, London, 1995.

4. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	2	2	2
CO3	3	2	3
CO4	3	2	3
CO5	3	3	3

-Not related 1-Low 2-Moderate 3-High

CE 235 Airport Planning

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

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

CO1	To do the planning of orientation of airport elements
CO2	Analysing the requirement of airport layout with respect to international regulation
CO3	Design Airport Pavement, Taxiway, and Apron
CO4	To understand visual aid required for safe landing and take-off operation from passenger and cargo terminal
CO5	Summarise the concept of the terminal service facility

2. Syllabus

- **AIRPORT PLANNING (05 Hours)**
  Airport planning: commercial service aviation, air cargo, and general aviation; civil aviation airports; major acts and policies of the Ministry of Civil Aviation in India
  Aviation organizations and functions: Federal Aviation Administration, International Civil Aviation Organization, Directorate General of Civil Aviation, Airports Authority of India. Airport planning studies: airport system plan, airport site selection, airport master plan, airport project plan; continuous planning process.

- **AIRCRAFT CHARACTERISTICS (06 Hours)**
  Landing gear configurations, aircraft weight, and engine types. (06 Hours) Atmospheric conditions affecting aircraft performance: air pressure, temperature, wind speed, and direction. Aircraft performance characteristics: speed, payload, range, runway performance, declared distances, wingtip vortices.

- **AIR TRAFFIC MANAGEMENT (06 Hours)**
  Air traffic separation rules: vertical separation, flight altitudes, longitudinal separation, and lateral separation. Navigational aids: ground-based systems, satellite-based systems.

- **GEOMETRIC DESIGN OF THE AIRFIELD (10 Hours)**
  Airport classification: utility airports, transport airports. (10 Hours) Runways: runway configurations, runway orientation, the wind rose, estimating runway length, sight distance, and longitudinal profile, transverse gradient, airfield separation requirements, obstacle clearance requirements. Taxiways and taxi lanes: widths and slopes, taxiway and taxi lane

separation requirements, sight distance and longitudinal profile, exit taxiway geometry, location of exit taxiways, design of taxiway curves and intersections, and end-around taxiways.

- **STRUCTURAL DESIGN OF AIRPORT PAVEMENTS (06 Hours)**
  Soil investigation and evaluation: CBR, plate bearing test, Young's modulus, the effect of frost on soil strength, subgrade stabilization. FAA pavement design methods: equivalent aircraft method, cumulative damage failure method. Design of flexible pavements: CBR method, layered elastic design. Design of rigid pavements: Westergaard's analysis, finite element theory, joints and joint spacing, continuously reinforced concrete pavements.

- **AIRPORT LIGHTING, MARKING, AND SIGNAGE (06 Hours)**
  Requirements of visual aids, approach lighting system configurations, visual approach slope aids, threshold lighting. Runway lighting, taxiway lighting. Runway and taxiway marking, airfield signage.

- **PLANNING AND DESIGN OF THE TERMINAL AREA (06 Hours)**
  Passenger terminal system and its components. (06 Hours) Design considerations: terminal demand parameters, facility classification, level of service criteria. Terminal planning process: overall space requirements, concept development, horizontal distribution concepts, vertical distribution concepts. Apron gate system: number of gates, ramp charts, gate size, aircraft parking type, apron layout, apron circulation, passenger conveyance to aircraft, apron utility requirements.

(Total Lectures: 45 hours)

3. Books Recommended

1. Khanna, S. K., Arora, M. G., and Jain, S. S. Airport planning and Design, Sixth Edition, Nem Chand and Bros, Roorkee, India, 2012.
2. Kumar, V., and Chandra, S. Air Transportation Planning and Design, Galgotia Publications Pvt. Ltd., New Delhi, India, 1999.
3. Ashford, N. J., Mumayiz, S. A., and Wright, P. H. Airport Engineering: Planning, Design and Development of 21st Century Airports, Fourth Edition, John Wiley & Sons, New Jersey, USA, 2011.
4. Horonjeff, R., McKelvey, F. X., Sproule, W. J., and Young, S. B. Planning and Design of Airports, Fifth Edition, McGraw-Hill, New York, USA, 2010.
5. Young, S. B., and Wells, A. T. Airport Planning and Management, Sixth Edition, McGraw-Hill, New York, USA, 2011.

4. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	3	1
CO2	2	2	2
CO3	3	3	3
CO4	1	1	2
CO5	2	2	2

-Not related 1-Low 2-Moderate 3-High

CE 237 Integrated Watershed Management

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

At the end of the Course the students will be able to:

CO1	Assess behavior of Watershed
CO2	Describe Watershed and Hydro-geomorphology
CO3	Develop suitable models for various types of Watersheds
CO4	Plan the watershed conservation practices
CO5	Apply GIS technique for Watershed Management

2. Syllabus

- **INTRODUCTION TO WATERSHED (05 Hours)**
  Definition and its components, Need of watershed management, Identification of watershed problems, Sustainability with watershed management, Watershed assessment concept, Comprehensive watershed management concepts.

- **BEHAVIOUR OF PHYSIOGRAPHY IN WATERSHED ASSESSMENT AND MANAGEMENT (05 Hours)**
  Physiography and physiographic regions – Geology, Soil, Topography, Climate, Precipitation, Hydrologic cycle.

- **WATERSHED AND HYDRO-GEOMORPHOLOGY (10 Hours)**
  Watershed Classifications, Stream classifications, watershed hydrology, Surface water assessment, Rainfall-runoff analysis, Groundwater assessment, infiltration and its measurement, Erosion process: factors affecting erosion, types of erosion, soil erosion models.

- **WATERSHED HYDROLOGY AND MODELLING (10 Hours)**
  Drainage area, Time-of-concentration and watershed lag, Runoff routing, Modelling process, Case study of sensitivity analysis of watershed management and planning.

- **SOIL AND WATER CONSERVATION (10 Hours)**
  Physical measures for watershed management by soil and water conservation, Storm water and flood management, Drought management, Integrated watershed management.

- **Geographical Information System (05 Hours)**
  Use of GIS and DEM for Watershed Assessment, GIS models its data requirement and limitations for Watershed assessment and analysis.

[Total Lectures: 45 hours]

3. Books Recommended

1. J V S Murthy, Watershed Management, New Age International (P) Limited Publishers, New Delhi, Reprint 2017(Second Edition).
2. FAO: Watershed Management and Field Manuals, UN, Rome, 1990.
3. S V Menon, Watershed Management: Case Studies, ICFAI University Press, 2008.
4. E M Tideman, Watershed Management – Guidelines for Indian conditions, Omega Scientific Publishers, New Delhi, 2007 (Eleventh Edition).
5. P A DeBarry, Watersheds: Processes, Assessment and Management, Hoboken, NJ: Wiley, 2004 (First Edition).

4. Mapping of COs and POs

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

1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	1	2	3
CO2	2	2	1
CO3	1	2	2
CO4	3	2	2
CO5	3	1	3

1-Low 2-Moderate 3-High

Fourth Semester (2nd year of UG) (Subjects)

CE 202 Concrete Technology

L	T	P	C
3	0	2	4

1. Course Outcomes (COs)

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

CO1	Evaluate the physical and mechanical properties of ingredients of concrete.
CO2	Conduct the experiments on fresh and hardened concrete.
CO3	Produce a concrete mix compatible to design stipulations.
CO4	Apply the knowledge of special concrete and concreting methods to field.
CO5	Assess in-situ strength of concrete performing the various non-destructive tests.

2. Syllabus

- **PROPERTIES OF CEMENT (06 Hours)**
  Manufacturing of Portland cement, Chemical composition of Portland cement, Hydration of cement, Setting of cement, Physical and chemical test for cement, Different types of cement, Important properties and applications.

- **PROPERTIES OF AGGREGATES (06 Hours)**
  Classification of aggregates, Important physical properties, Mechanical properties, Specific gravity, Bulk density, Moisture content and Water absorption of aggregates, Sieve analysis, Fineness modulus, Grading curves, Gap Grading, Deleterious Substances in aggregates, Alkali-aggregate reaction, Maximum size of aggregates.

- **MINERAL AND CHEMICAL ADMIXTURES (05 Hours)**
  Chemical Admixtures, Accelerators, Retarder, Water reducing agents (WRA) or Plasticizers, Air Entraining Agents, Corrosion Inhibitors, Water proofing compounds, Mineral Admixtures- Fly ash, Silica Fume, Ground Granulated Blast Furnace Slag (GGBFS), Metakaolin etc.

- **FRESH CONCRETE (05 Hours)**
  Definition of workability, Factors affecting workability, Measurement of workability - Slump test, Compacting factor test, Mixing of concrete ingredients, Types of mixtures, Vibration of concrete, Types of vibrators – Internal vibrators, External vibrators, Table vibrators, Segregation and bleeding.

- **STRENGTH OF CONCRETE (05 Hours)**

  Abram's water cement law, Factors affecting strength of concrete, Different methods of Curing, Steam Curing at Atmospheric Pressure and High-Pressure Curing, Warm water method, Maturity of concrete.

- **TESTING OF HARDENED CONCRETE (06 Hours)**

  Need for testing, Compression test – Cube, cylinder, Prism and equivalent cube test, Effects of various factors on test results (e.g. End conditions, Capping, Moisture content, Height/Diameter ratio, Shape of specimen, Size of specimen), Rate of loading, Duration of loading, Comparison of strength of cube and cylinder specimens, Split tensile test, Flexure test, Non-destructive testing, needs and applications of NDTs, Rebound hammer test, Ultrasonic Pulse Velocity test, Core test. .

- **MIX DESIGN (06 Hours)**

  Definition and need for designing mixes - Methods of mix design – IS 10262 method of mix design in detail with examples.

- **SPECIAL CONCRETE AND CONCRETING METHODS (06 Hours)**

  Polymer Concrete, Geopolymer concrete, Fibre Reinforced Concrete, Light Weight Concrete, High Density Concrete, Hot and Cold weather Concreting, Ready mixed concrete, Self-compacting concrete, Pre placed aggregate concrete, Vacuum processed concrete, Shotcrete and Gunitting.

(Total Lectures: 45 hours)

3. Practical

1. To determine fineness of cement.
2. To determine consistency, initial and final setting time of cement.
3. To determine soundness of cement.
4. To determine compressive strength of cement.
5. To determine mechanical properties of fine aggregates.
6. To determine mechanical properties of coarse aggregates.
7. To design a concrete mix of two different grades.
8. To determine workability of concrete and study of effect of super-plasticizers on it.
9. To determine setting time of concrete.
10. To conduct destructive and non-destructive tests on standard concrete cubes.
11. To determine elastic modulus and split tensile strength of concrete.
12. To determine flexural strength of plain concrete.

4. Books Recommended

1. A M Neville, Properties of Concrete, Pitman Publishing Company, Bath, U.K., 1973.
2. M S Shetty, Concrete Technology, Theory and Practice" 2nd ed., S. Chand and Company, New Delhi, 1986.
3. M L Gambhir, Concrete Technology, Tata McGraw Hill Company, New Delhi, 1986.

4. Shanthakumar, Concrete Technology, Tata McGraw Hill Company, New Delhi, 2006.
5. G E Troxell and H E Davis, Composition and Properties of Concrete, Mc Graw Hill Publication, 1998.

5. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	1	2
CO2	1	1	2
CO3	3	2	2
CO4	2	1	2
CO5	2	1	1

-Not related 1-Low 2-Moderate 3-High

CE 204 Highway Materials And Construction

L	T	P	C
3	0	2	4

1. Course Outcomes (COs)

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

CO1	Characterise different unbound and bound materials like soil, aggregate, bitumen and various mix specifications to check their suitability
CO2	Design the bituminous mix as per the Indian guidelines
CO3	Design the cementitious mixes used in road construction
CO4	Appraise the construction of pavement layers as per the Indian practices
CO5	Prepare quality assurance and quality control plans in an attempt to construct better performing pavements

2. Syllabus

- **SOIL** **(06 Hours)**
  Role of soil testing in performance of road - Subgrade requirements in road constructions, Analysis of soil behavior, Characterisation of soil as subgrade and embankment material, Resilient modulus of soil.

- **SOIL STABILIZATION** **(04 Hours)**
  Need of soil stabilisation, types, material requirements and design.

- **AGGREGATE** **(04 Hours)**
  Road making aggregates - Mechanical Properties of aggregates and their tests - Design of aggregate gradation.

- **BITUMEN** **(06 Hours)**
  Bituminous binders for pavement, Penetration, Viscosity and Performance Grade of bitumen, Emulsion- properties, types, Cutbacks, modified binders.

- **BITUMINOUS MIX** **(06 Hours)**
  Requirements of a bituminous mix, Mix design, Characterisation of mix properties used for pavement design.

- **CEMENTITIOUS MIXES** **(03 Hours)**
  Types of cementitious mixes, Requirements of cement concrete mixes for pavement, Design of Pavement Quality Concrete, Design of Dry Lean Concrete, Design of cement treated bases and sub-bases.

- **HIGHWAY CONSTRUCTION (07 Hours)**
  Hot mix plant, Cement concrete batching plant, Paving machineries.

- **QUALITY CONTROL AND QUALITY ASSURANCE PLAN (03 Hours)**
  Quality control tests during and after construction of each layer, frequency of quality control tests.

(Total Lectures: 45 hours)

3. Practical

1. To Determination of C.B.R. value of Subgrade soil.
2. Determination of Abrasion value and Shape Index.
3. Determination of Impact and Ten percent fines value.
4. Determination of soundness of aggregate.
5. Determination of polished stone value
6. Determination of ductility.
7. Determination of softening point.
8. Determination of penetration value.
9. Determination of viscosity.
10. Determination of bitumen content in bituminous mix by centrifuge extraction.
11. Marshal stability and flow test
12. Determination of Gmm and Gmb
13. Determination of compressive strength and flexural strength of the cement concrete.

4. Books Recommended

1. Khanna S.K., Justo C.E.G., Veeraragavan A., Highway Engineering, Nem Chand and Sons, 2019.
2. Kadiyali L.R.Highway Engineering, Khanna Publishers, 2019.
3. Papagiannakis, A.T., Masad, E.A., Pavement Design and Materials, Wiley, 2008.
4. Kandhal, P.S., Bituminous Road Construction in India, PHI Learning Pvt.Ltd, 2016.
5. Hunter, R.N., Andy, S., John, R., The Shell Bitumen Handbook, ICE Publishing, 2015.
6. Ministry of Road Transport and Highways, Specifications for Road and Bridge Works, Indian Roads Congress, 2013.

5. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	3	3
CO5	3	3	3

-Not related 1-Low 2-Moderate 3-High

CE 206 Surveying II

L	T	P	C
3	1	2	5

1. Course Outcomes (COs)

At the end of the Course the students will be able to:

CO1	Prepare topographic map of hilly region.
CO2	Conduct Geodetic Survey using Triangulation
CO3	Establish the horizontal control points in Trilateration
CO4	Set out the curves using various survey methods
CO5	Analyze the problem and its remedial measures pertaining to hydrographic Survey

2. Syllabus

Trigonometric levelling (04 Hours)

Indirect levelling, heights and distances, methods, direct levelling on steep ground,

Tacheometric Survey (08 Hours)

Purpose, Principles of Tacheometry, Different Systems of Tacheometry, Various instruments, stadia constants, analytic lens, subtense bar, field work in tacheometry, reduction of readings, errors and precisions, Tacheometric Traversing,

Triangulation (12 Hours)

Introduction to Geodetic Survey, Principles – Classification of triangulation systems - Selection of stations - Signals and towers - Baseline measurement and correction - Extension of base - base net - Satellite station - Reduction to center - Introduction to theory of errors and technical terms

Trilateration (04 Hours)

Introduction, use of trilateration, Advantages and Disadvantages of Trilateration, Comparison of Trilateration with Triangulation, Reconnaissance, Geometrical Figures and Precision in Trilateration, Adjustment of Trilateration

Setting Out Curve (10 Hours)

Introduction, classification of curves, Definition and Notations, Simple Circular Curves, Methods of Setting out Curves, Compound Curve, Transition Curves, Vertical Curves

Hydrographic Surveys (07 Hours)

Objects, Applications, Establishing controls, Shore line survey, Sounding, Sounding equipment, Methods of locating soundings, conventional and using GPS, Reduction of soundings, Plotting of soundings, Nautical sextant and its use, Three point problem and its use, solution of three point problem by all methods, Tides and tide gauges, determination of MSL

(Total Lecture Hours: 45)

3. PRACTICALS / DRAWING*:

Sr. No.	Name of Practical	Duration
1.	Measurement of Vertical Angle with Vernier Theodolite	01 week
2.	Measurement of Vertical Angle with Digital Theodolite	01 week
3.	Determination of Tacheometric constant K and C	01 week
4.	Tacheometric Exercise with stadia method	01 week
5.	Tacheometric Exercise with tangential method	01 weeks
6.	Determination of horizontal distance by subtense bar method	01 week
7.	Contour Survey by radial method using Tacheometer (Digital Theodolite) and plotting of Contour	02 weeks
8.	Exercise on Triangulation Work without satellite Station and with satellite Station	02 weeks
9.	Adjustment of Triangles Closure and Station closure and Plotting of Traverse with horizontal Control Points	02 weeks
10.	Setting out of circular Curve by Rankine (Deflection Angle) Method	02 weeks
11.	Final Submission of journal and drawings	01 week
	Total	**15 weeks**

Student has to prepare a journal with description of practical as well as to prepare drawing of given exercise in prescribed drawingsheet by the teacher and has to submit the same.

4. BOOKS RECOMMENDED:

1. Arora K.R., “Surveying and Levelling, Vol. II ”, Standard Publications, Delhi (2019).
2. Kanitkar T.P. and Kulkarni S.V., “Surveying and Levelling, Vol. II”, Vidyarthi Gruh Prakashan, Pune (2014).
3. Subramanian, R., “Surveying and Leveling” Oxford University Press, New Delhi (2012)
4. James M Anderson and Adward M Mikhail, “Surveying theory and practice” Tata McGraw Hill Publication (2017)
5. W. Schofield, “Engineering Surveying Vol. III”, Butterworth-Heinemann Publication, New Delhi (2007)
6.

5. CO-PO-PSO_Mapping

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

1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	2	1	1
CO3	2	1	3
CO4	2	2	3
CO5	1	2	3

1-Low 2-Moderate 3-High

CE 208 Elementary Structural Mechanics

L	T	P	C
3	0	2	4

1. Course Outcomes (COs)

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

CO1	Find the shear and compressive stresses in structural member subjected to various loadings.
CO2	Calculate principal stresses and strains for structural member
CO3	Analyse statically determinate beams and frames with internal hinges
CO4	Compute displacement of statically determinate trusses and beams
CO5	Construct influence lines for determinate structures.

2. Syllabus

- **PRINCIPAL STRESSES & STRAINS (04 Hours)**
  Principal plane – Principal stress – Tangential and normal stress – Derivation of Major and Minor principal stresses for different cases – Mohr's circle graphical method.

- **TORSION (05 Hours)**
  Basic theory of Torsion – Solid shaft – Hollow shaft – Power transmitted by shaft – Composite shafts.

- **COLUMNS AND STRUTS (05 Hours)**
  Euler's theory for columns – Different end conditions – Rankine's formula – Limitations of Euler's theory.

- **BASIC INTRODUCTORY CONCEPTS OF STRUCTURES (03 Hours)**
  Structural Systems – Degrees of Freedom - Determinate and indeterminate structures.

- **ANALYSIS OF STATICALLY DETERMINATE STRUCTURES (04 Hours)**
  Analysis of Beams with internal hinges – Analysis of frames.

- **DISPLACEMENT OF STATICALLY DETERMINE STRUCTURES (12 Hours)**
  Determination of slope and deflections of beams using successive integration method – Macaulay's Method- Conjugate Beam Method- Determination of deflection of trusses using virtual work method.

- **INFLUENCE LINES FOR DETERMINATE STRUCTURES (12 Hours)**
  Concept of Influence lines – Influence lines for reactions, shear force and bending moment in beams – load position for maximum shear force and bending moment at a section in beam – Absolute maximum bending moment in beams- Influence lines for member forces in Trusses – Muller Breslau's Principle.

(Total Lectures: 45 hours)

3. Practical

1. Torsion Test on MS Specimen
2. Compression test on CI Columns
3. Deflection of simply supported beam
4. Deflection of cantilever beam
5. Reactions, Fixed end moment and deflection of a propped cantilever
6. Clerks Maxwell reciprocal Theorem
7. Behaviour of three hinge arch with a point load at centre
8. Behaviour of two hinge arch with a point load at centre
9. Behaviour of two pinned arch for a uniformly distributed load
10. Behaviour of three pinned arch for a uniformly distributed load
11. Behaviour of two pinned arch due to moving load
12. Behaviour of three pinned arch due to moving load
13. Behaviour of simply supported beam due to moving load
14. Deflection of truss
15. Study of different 2D & 3D structural models .

4. Books Recommended

1. Timoshenko S & Young D H "Elements of Strength of Materials", Tata Mc Graw Hill, New Delhi,2006
2. Beer F. P. & Johnston S J, "Strength of Materials" Tata Mc Graw Hill Publication, New Delhi,2016.
3. Hibbler R C, "Structural Analysis",6th edition, Pearson Prentice Hall, New Delhi, 2018
4. Thandavamoorthy T S, " Structural Analysis", Oxford University Press, New Delhi, 2011
5. Gali A, Newville A M, Brown T G, "Structural Analysis – A Unified Classical and Matrix Approach, " Sixth Edition, spon Press, UK, 2009.

5. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	2	3
CO2	2	2	3
CO3	3	2	2
CO4	3	2	3
CO5	3	2	2

-Not related 1-Low 2-Moderate 3-High

CORE ELECTIVE/ ELECTIVE 2

4th Semester- 2nd Year UG

CE 232 Advanced Construction Technology

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

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

CO1	Understand and apply modern technologies in construction systems.
CO2	Evaluate and implement advanced construction materials for sustainable and specialized applications.
CO3	Apply trenchless construction and rehabilitation methods for underground utility projects.
CO4	Analyze and execute underground and offshore construction techniques.
CO5	Utilize automation and innovative technologies in modern construction practices.

2. Syllabus

- **MODERN TECHNOLOGIES (08 Hours)**
  Formwork systems, different materials for formwork like wood, steel, aluminium, plastic, fibre glass, laminated veneer lumber, new joineries and fixtures of forms, modern scaffolding technologies, doors and windows modern materials and fixtures, Building cladding system with aluminium composite sheets. advanced paints of buildings and infrastructures like weather proof coating paint, anti-fungal paint etc.

- **ADVANCED CONSTRUCTION MATERIALS (08 Hours)**
  Artificial manufactured sand and its application areas, different fly ash and its applications, different slag like steel slag and blast furnace slag and its applications, geosynthetics like geogrid, geofoam, geomembrane, geojute and geotextiles. geopolymers and its applications, fibres in concrete like steel fibre, polypropylene fibres and glass fibres, sustainable materials / eco-friendly materials / green construction materials, types of mortars, special mortars, types of nanomaterial such as fly ash, micro silica, silica fume, GGBS. self-compacting concrete, ferro cements, fire resisting materials, water proofing construction chemicals, joint sealants, thermal insulation materials, graphene.

- **TRENCHLESS CONSTRUCTION (10 Hours)**
  Introduction, necessity, trenchless construction methods – pipe jacking, utility tunnelling, horizontal auger boring, micro-tunnelling, pilot tube micro-tunnelling, horizontal directional drilling (HDD), guided drilling; trenchless repair/rehabilitation methods – holistic methods (cured in place pipe [CIPP], slip lining, deformed and reformed, spray in place pipe) and localized methods (point CIPP, mechanical joint sealing, robotics repair); trenchless replacement methods – pipe bursting methods; trenchless cleaning methods – high pressure water jetting (HPWJ), smart pig; BIM for underground trenchless technology.

- **UNDERGROUND AND OFFSHORE CONSTRUCTION (10 Hours)**
  Site investigation and geological studies, top-down and bottom-up underground construction, pneumatic breakers, advanced drilling methods, blasting and explosives. Different tunnelling technologies like mechanized, shield, micro etc. offshore: barges, cranes, derrick barges, drilling vessels, different stages of offshore construction, offshore facilities and fabrication methods, safety in underground and offshore construction.

- **AUTOMATION IN CONSTRUCTION (05 Hours)**
  Advance computer technology in construction, internet of things (IoT) in construction, RFID technology, building information modelling, virtual design and construction technologies, augmented and virtual reality (AR & VR) in construction, artificial intelligence (AI) in construction.

- **INNOVATIVE CONSTRUCTION TECHNOLOGIES (04 Hours)**
  Demolition techniques for various structures, off-shore construction techniques, micro piling, underground utility construction.

(Total Lectures: 45 hours)

3. Books Recommended

1. R Chudley and R Greeno, Advanced Construction Technology, Pearson Education, Harlow, 2006
2. R E Smith, Prefab Architecture: A Guide to Modular Design and Construction, John Wiley and Sons, Hoboken, 2010.
3. G Beer, Technology Innovation in Underground Construction, CRC Press, London, 2009.
4. L H Forbes and S M Ahmed, Modern Construction: Lean Project Delivery and Integrated Practices, CRC Press, New York, 2010.
5. G Shen, P Brandon and A Baldwin, Collaborative Construction Information Management, Routledge, Oxford, 2009.

4. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

-Not related 1-Low 2-Moderate 3-High

CE 234 Building Maintenance

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Understand the principles of building maintenance.
CO2	Prepare a framework for asset and facility management.
CO3	Identify and control defects of building fabric.
CO4	Identify issues and control the defects of building services.
CO5	Develop the building management system.

2. Syllabus

- **PRINCIPLES OF MAINTENANCE (06 Hours)**
  Terminology of maintenance and repairs, objective, Life expectancy of buildings, Property inspection and report, Types of maintenance, Aspects of building maintenance, Maintenance planning process and its assessment, work progress, means of effective maintenance and access for maintenance, Maintenance budget estimate, Agencies causing deterioration.

- **ASSET AND FACILITY MANAGEMENT (09 Hours)**
  Aspects of Asset and Facility Management, Organisation Structure, Methodology, Resource requirements, Procurement and classification, Preventive and corrective maintenance, Maintenance problem and root causes, Maintenance cost, Specifications for maintenance work, Quality Control, inspection and reporting, standard norms, responsibility of occupants, common area of maintenance.

- **BUILDING FABRIC MAINTENANCE (12 Hours)**
  Prevention of cracks, repairs, retrofitting and seismic strengthening of buildings, construction chemical, Functional, structural and aesthetical failures, Case studies, Methodology to investigate of failures in building, Diagnostic testing methods and equipment, Material test, NDT, Repair of cracks in concrete and masonry, grouting, Repair and maintenance of foundation, basement and DPC, The Efflorescence Triangle, Repair of building joints, Repair and maintenance of RCC element.

- **MAINTENANCE OF BUILDING SYSTEMS (12 Hours)**

  Common causes for maintenance problems, painting, building pathology, maintenance of plumbing systems, maintenance of drainage systems, maintenance of Heating, Ventilation and Air Conditioning (HVAC) systems, maintenance of electrical installations, operations and maintenance of lifts and escalators, maintenance of fire fighting systems, roads and pathways maintenance and upkeep, maintenance of landscaping and horticulture works, solid waste management, pest and rodent control.

- **BUILDING MANAGEMENT SYSTEMS (BMS) (10 Hours)**

  Components, responsibilities related to BMS, good practices, Information Management, documentation and checklists, security services for building occupants and assets/facilities, Personal Protective Equipment (PPE), maintenance tools, good practices.

(Total Lectures: 45 hours)

3. Books Recommended

1. National Building Code 2016, Volume 2, Part 12.
2. P. C. Varghese, Maintenance, Repair & Rehabilitation & Minor Works of Buildings, 1st Edition, PHI Learning Private Limited, 2015.
3. Pieter De Wilde, Building Performance Analysis, Wiley Blackwell, 2018.
4. Wolfgang FE Praiser and Jacqueline C Vischer, Assessing Building Performance, Elsevier, 2005.
5. David Watt, Building Pathology, 2nd Edition, Blackwell Publishing, 2007.
6. James Douglas and Bill Ransom, Understanding Building Failures, 4th Edition, Routledge, 2013.

4. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	2	2	1
CO3	2	3	2
CO4	2	3	2
CO5	3	3	3

-Not related 1-Low 2-Moderate 3-High

CE 236 ADVANCED WATER AND WASTEWATER TREATMENT

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Analyse the quality and quantity of water and wastewater.
CO2	Describe secondary and tertiary wastewater treatment processes.
CO3	Explain the basis for designing different units of water and wastewater treatment.
CO4	Describe advanced water and wastewater treatment process, including natural processes.
CO5	Design reclamation and recycling units for wastewater.

2. Syllabus

- **INTRODUCTION (10 Hours)**
  Objectives of water and waste-water treatment - classification of treatments, parameters commonly employed to indicate pollution strength – standards for water quality and wastewater disposal – Self-purification of water bodies – Simple Mathematical models. Introduction to process selection and analysis - Measurement of wastewater flow - Variation in wastewater flow.

- **WATER AND WASTEWATER TREATMENT PROCESSES (15 Hours)**
  Theory and design of sedimentation, coagulation, filtration, aeration units. Types of sedimentation-Plate settlers, Diffusion double layer theory for colloids, Mechanisms of destabilization of colloids, Perikinetic and Orthokinetic Flocculation, Velocity Gradient, Clari-flocculator, Mechanisms of filtration, mono media and multimedia filters kinetics of disinfection, types of aerators , Film coefficients and equilibrium relationship for aeration.

- **ADVANCED PROCESSES (12 Hours)**
  Equalization – Neutralization - Advanced Oxidation Processes - Working principle, application and maintenance of Ion-exchange, reverse osmosis, adsorption, Membrane filtration, ultra-filtration, electro-dialysis. Desalination. Adsorption – Isotherms, Wastewater disinfection. Aquatic Plant Systems, Constructed Wetlands and Vermi-culture.

- **RECLAMATION AND REUSE OF WASTEWATER (08 Hours)**
  Tertiary treatment for removal of residual organics, removal of nutrients, recycling and reuse of wastewater, Case studies from India

(Total Lectures: 45 hours)

3. Books Recommended

1. R L Droste and R L Gehr, Theory and Practice of Water and Wastewater Treatment, Wiley Publication, New Delhi, 2018.
2. Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, Tata McGraw-Hill, New Delhi, 2003.
3. D G Rao, R Senthilkumar, J A Byrne, and S Feroz, Wastewater Treatment Advanced Processes and Technologies, CRC Press, New York, 2012.

4. M L Davis, Water and Wastewater Engineering, McGraw-Hill, New Delhi, 2010.
5. Manual on Water Supply & Treatment 3rd Ed. Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1999.

4. Mapping of COs and POs

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

5. COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	3	2	2
CO3	3	2	2
CO4	3	3	3
CO5	3	3	3

CE 242 Environmental Geo-technology

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Identify the subsurface contamination and describe contaminant transport through geo-media.
CO2	Comprehend the characteristics of municipal solid waste and industrial by-products for their reuse in civil engineering structures.
CO3	Illustrate the application of various geosynthetics materials in the construction of landfills.
CO4	Design the solid waste disposal system and its components.
CO5	Design the slurry waste containment system using various methods of raising.

2. Syllabus

- **SUBSURFACE CONTAMINATION AND CONTAMINANT TRANSPORT (07 Hours)**

  Sources of subsurface contamination, Detection of polluted zones, Control and Remediation, Transport of contaminants by advection, diffusion, dispersion phenomena; Chemical mass transfer processes through sorption & desorption, precipitation & dissolution.

- **COMPOSITION OF SOLID WASTES (03 Hours)**

  Composition and characterization of solid waste; Determination of moisture content and organic content of MSW; Material loss fraction; Factors affecting unit weight of MSW.

- **CONTAINMENT OF SOLID WASTE IN LANDFILLS (10 Hours)**

  Landfills – Types, shapes, sizes; Components of landfill with their functions and requirements; typical sections of liner and cover system for hazardous and non-hazardous landfills; Design of cover systems: Introduction; Common final cover systems; Infiltration theories; Calculating percolation through cover systems; Erosion assessment; Evaluation of drainage layer capacity; Cover slope stability analysis.

  Design of liner systems: Geomembrane stability against Tensile stress under self-weight, Tensile Stress under waste down-drag during filling and Adequate anchorage; Stability of soil over Geomembrane; Settlement of land fill base on soft soil; Stability for moving vehicle on ramp; Selection of drainage layer material and thickness for leachate collection.

- **CHARACTERISTICS OF GEOSYNTHETICS (07 Hours)**
  Clay liner and Compatibility: Compacted clay liner (CCL); Liner specifications; Clay mineralogy and its role in hydraulic performance of CCL; Hydraulic conductivity estimation;
  Geosynthetic Clay Liner (GCL): Introduction and basic properties; Swelling and hydraulic characteristics; Solute and gas migration; Installation of GCL; Role of GCL in composite liners; Equivalency of GCL and CCL.
  Geomembrane Liner (GM): Physico-mechanical response of GM; Endurance properties of GM, Service life estimation by considering ageing of GM; Leakage through GM and Installation & seaming of GM.
- **CONTAINMENT OF SLURRY WASTES (07 Hours)**
  Ponds or Impoundments; Operation; Embankment construction; Methods of raising in stages; Design aspects; Environmental impact and control. Design and maintenance of ash pond for fly ash disposal.
- **VERTICAL BARRIERS FOR CONTAINMENT (04 Hours)**
  Suitable types and requirements of vertical barriers; Soil-Bentonite slurry trench walls; Cement-Bentonite slurry trench walls.
- **GEOTECHNICAL REUSE OF WASTE MATERIAL (07 Hours)**
  Waste characteristics for soil replacement; Engineering Properties of waste and geotechnical reuse; sustainability; Waste material in embankments and fillsWeak Deposits- Identification-Problems associated with weak deposits- Mitchel chart of applicability of treatment methods.

(Total Lectures: 45 hours)

3. References

1. Sharma, H. D. and Reddy, K. R. “Geoenvironmental Engineering: Site Remediation, Waste Containment and Emerging Waste Management Technologies”, John Wiley & Sons, New Jersey, USA. 2004.
2. Koerner, R. M., “Design with Geosynthetics”, Xlibris Corporation, USA. 2012.
3. Gulhati, S. K. and Datta, M., Geotechnical engineering, Tata McGraw-Hill, New Delhi, 2005.
4. Regulations and guidelines developed by USEPA, http://www.epa.gov/
5. Regulations and guidelines proposed by CPCB, Ministry of Environment & Forest, GOI, http://www.cpcb.nic.in/
6. Qian, X., Koerner, R.M. Gray, D.H. “Geotechnical Aspects of Landfill Design and Construction”. Pearson, 2001.

4. Mapping of COs and POs

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

1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	3	2	3
CO3	3	2	2
CO4	3	3	2
CO5	3	3	2

1-Low 2-Moderate 3-High

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CE 244 Rock Mechanics

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Identify different types of rock and rock mass for its suitability and uses in civil engineering applications
CO2	Classify the rock and rock mass on the basis of different rating systems
CO3	Analyze the strength and deformation behavior of rock and rock mass
CO4	Apply the laboratory and field results to determine engineering properties of rock and rock mass
CO5	Provide the engineering solutions for weak soil and rock deposits

2. Syllabus

- **INTRODUCTION (04 Hours)**
  Scope of rock mechanics, Object of rock exploration, Methods of rock exploration, Rock quality designation, Geophysical prospecting, Problems related to rock mechanics

- **PHYSICAL AND ENGINEERING PROPERTIES OF ROCKS (08 Hours)**
  Rock materials, Physical properties, Strength behaviour in uniaxial compression, tension and triaxial state, Stress-strain relationships, Factors influencing strength, Failure mechanism, Anisotropy, Brittle – ductile transition, In-situ determination of elastic properties of rocks by dynamic method, Weathered rocks

- **DETERMINATION OF ENGINEERING PROPERTIES OF ROCKS (06 Hours)**
  Laboratory testing methods - Compressive strength test, Tensile strength test, Permeability, Direct shear test, Test for internal stress in rock, Indirect methods, Flexural strength of rock

- **FAILURE CRITERIA AND RHEOLOGY (06 Hours)**
  Coulomb, Mohr's, Griffiths and Modified Griffiths criteria and Empirical criteria, Creep and its measurement, Rheology and rheological models

- **ROCKMASS BEHAVIOUR (06 Hours)**
  Rock discontinuities - Joints, Faults, Folds, Strength and deformation behaviour of discontinuities, Rockmass behaviour, Shear strength of jointed rocks, Strength criteria for rockmass

- **INTACT AND ROCKMASS CLASSIFICATIONS (07 Hours)**
  Deere and Miller, Geological classification, ISRM, Terzaghi, RQD, RSR, RMR and Q classifications, Rating, Applications

- **FIELD TESTS** **(04 Hours)**
  Necessity, Requirements of in-situ tests, Plate load test, Pressure tunnel test, Bore hole test

- **IMPROVEMENT IN PROPERTIES OF ROCKMASS** **(04 Hours)**
  Necessity, Grouting, Rock bolting, Cable anchorage

(Total Lectures: 45 hours)

3. Books Recommended

1. VS, Lama RD, Saluja SS, Handbook on Mechanical Properties of Rocks, Trans. Tech., Bay Village, Ohio, 1974.
2. Goodman RE., Introduction to Rock Mechanics, Jhon Wiley, London, 1989.
3. Bieniawski ZT, Engineering Rock Mass Classifications, John Wiley and Sons, New York, 1989.
4. Jaeger JC, Cook NG, Zimmerman R, Fundamentals of Rock Mechanics, Blackwell Publishing, Oxford, 2009.
5. Zhang L, Engineering Properties of Rocks, Butterworth-Heinemann, Cambridge, 2016.

4. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	2	1	2
CO3	3	2	2
CO4	3	2	2
CO5	3	3	3

-Not related 1-Low 2-Moderate 3-High

CE 246
Pavement Construction and Evaluation

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1:	Select appropriate earth moving and compaction equipment depending upon the requirement.
CO2:	Prepare quality assurance and quality control plans in an attempt to construct better performing pavements.
CO3:	Evaluate the pavements based on the functional characteristics.
CO4:	Evaluate the pavements based on the structural characteristics.
CO5:	Select maintenance technique depending upon the pavement condition.

2. Syllabus

- **HIGHWAY CONSTRUCTION EQUIPMENT** **(12 Hours)**
  Applications and safety aspects of earth moving equipments, compaction equipments, road making equipments, concreting equipments and paving equipments, Hot mix plants, ready mix plants
- **PAVEMENT CONSTRUCTION** **(09 Hours)**
  Construction and preparation of subgrade, sub-base, base course, construction of bituminous layers, cement concrete surface course as per MoRT&H specifications, Quality control tests during and after construction.
- **FUNCTIONAL EVALUATION OF PAVEMENTS** **(09 Hours)**
  Introduction, factors affecting pavement deterioration, functional condition evaluation techniques, roughness measurements, Identification of uniform sections, serviceability concepts, visual and ride rating techniques.
- **STRUCTURAL EVALUATION OF PAVEMENTS** **(09 Hours)**
  Structural condition evaluation techniques, NDT procedures, rebound deflection, deflection bowl measurement and analysis, IRC overlay design method, structural evaluation using falling weight deflectometer, back calculation of layer moduli, ground penetrating radar for pavement evaluation, evaluation of pavement safety: skid resistance and hydroplaning.
- **PAVEMENT MAINTENANCE** **(06 Hours)**
  Routine maintenance, periodic maintenance, special repairs, responsive maintenance programme, rehabilitation and reconstruction, treatment strategies and selection criteria.

(Total contact hours: 45)

3. REFERENCES:

1. **Huang, Y.H.** *Pavement Analysis and Design*, Pearson Prentice Hall, New Jersey, USA, 2004.
2. **Mallick, R.B.** and **T. El-Korchi.** *Pavement Engineering – Principles and Practice*, CRC Press, Taylor and Francis Group, Florida, USA, 2009.
3. **Ministry of Road Transport and Highways.** *Specifications for Road and Bridge Works*, Fifth Edition, Indian Roads Congress, New Delhi, India, 2013.
4. **Papagiannakis, A.T.** and **E.A. Masad.** *Pavement Design and Materials*, John Wiley and Sons, New Jersey, USA, 2008.
5. **Yoder, E.J.** and **M.W. Witczak.** *Principles of Pavement Design*, Second Edition, John Wiley and Sons, New York, USA, 1975.

Mapping of COs and POs

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

1-Low 2-Moderate 3-High

Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	3	3
CO5	3	3	3

1-Low 2-Moderate 3-High

CE 248 Railway Engineering

L	T	P	C
3	1	0	4

1. Course Outcomes (COs)

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

CO1	Identify the Components of Railway Track, different Railway Gauges
CO2	Design track Gradients as per given requirements and Discuss various Types of Track Turnouts
CO3	Describe purposes and facilities at Railway Stations
CO4	Understanding Interlocking and modern signal system
CO5	Describe Surface Defects on Railway Track and Their Remedial Measures

2. Syllabus

- **PLANNING OF RAILWAY LINES NETWORK (05 Hours)**
  Railways operational system, historical background of Indian railways, plans and developments, policy and standards, traffic forecast and surveys, railway alignment, project appraisal, and organization setup.

- **COMPONENT OF RAILWAY TRACK AND ROLLING STOCK (06 Hours)**
  Permanent way, forces acting, rails, the function of rails, rail fixtures and fastenings, sleepers and ballast, rail joints, elements of junctions and layouts, types of traction, locomotives and other rolling stock, brake systems, resistance due to friction, wave action, wind, gradient, curvature, starting, tractive effort of a locomotive, hauling power of a locomotive.

- **GEOMETRIC DESIGN OF RAILWAY TRACK (08 Hours)**
  Right of way and formation, field investigation, geometric design elements, safe speed on curves, speeds computation, string lining of curves, gradients, grade compensation, railway cant and cant deficiency, traction.

- **TRACK CONSTRUCTION (06 Hours)**
  Special considerations and construction practices, track laying, Introduction of the maintenance programme, Monsoon, Pre-Monsoon & Post-Monsoon Maintenance, Causes for Maintenance, Routine Maintenance, Tools for Railway Track Maintenance & Their Functions,Surface Defects and Their Remedial Measures, track drainage, track circuited lengths, track tolerances, mechanized method, off track tampers, shovel packing, ballast confinement and directed track maintenance, bridge maintenance, renewal, classification of renewal works, through sleeper renewals, mechanized relaying, track renewal trains.

- **SIGNALING AND INTERLOCKING (04 Hours)**
  Objectives, classification, fixed signals, stop signals, signaling systems, mechanical signaling systems, electrical signaling systems, systems for controlling train movement, interlocking, and modern signaling installations.

- **RAILWAY ACCIDENTS AND SAFETY (06 Hours)**
  Train accidents, collision and derailments and their causes, restoration of traffic, safety measures, disaster management, classification of level crossings, accidents at level crossings, remedial measures, and maintenance of level crossings.

- **RAILWAY STATION AND YARDS (06 Hours)**
  Site selection, facilities, classification, platforms, building areas, types of yards, catch sidings, ship sidings, foot over bridges, subways, cranes, weighbridge, loading gauge, end loading ramps, locomotive sheds, ash-pits, water columns, turntable, triangles, traverser, carriage washing platforms, buffer stop, scotch block, derailing switch, sand hump, fouling mark. .

- **HIGH-SPEEDED RAILWAYS (04 Hours)**
  Modernization of railways, the effect of high-speed track, vehicle performance on track, high-speed ground transportation system, ballastless track, track requirement for bullet trains, elevated railways, underground and tube railways.

(Total Lectures: 45 hours)

3. Books Recommended

1. Satish Chandra and M. Agrawal, Railway Engineering, Second Edition, Oxford University Press, 2013.
2. Agarwal, M.M. Indian Railway Track, Prabha & Co., New Delhi, India, 1988.
3. Chandra S. and M.M. Agarwal Railway Engineering, Oxford University Press, New Delhi, India, 2007.
4. Gupta, B.L. Text Book of Railway Engineering, Standard Publishers, New Delhi, India, 1982.
5. S.C. Saxena and S.P. Arora, A text book of Railway engineering, Dhanpat Rai, 2001.

4. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	1	2
CO2	3	3	2
CO3	1	2	3
CO4	2	2	3
CO5	3	2	2

-Not related 1-Low 2-Moderate 3-High

CE 252 Traffic Engineering and Management

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Identify basic characteristics of traffic stream at micro and macro level.
CO2	Conduct traffic studies and analyze traffic data for practical applications.
CO3	Characterise heterogeneous traffic stream behaviour.
CO4	Design and plan different roadway facilities and elements and capacity estimation of different facilities.
CO5	Analyse and evaluate the safety of road users at different traffic environments.

2. Syllabus

- **TRAFFICCHARACTERISTICS (06 Hours)**
  Introduction, Fundamental parameters of traffic and relationships; Time headways, temporal, spatial and flow patterns; Interrupted and un-interrupted traffic; Microscopic and macroscopic speed characteristics; Vehicular speed trajectories; Speed characteristics-mathematical distributions; Speed and travel time variations, Computation of AADT, Design Hourly Volume.

- **TRAFFICFLOWMEASUREMENTS (06 Hours)**
  Traffic study components, types of data; Volume studies; Speed studies; Travel time and delay studies; Intersection studies,Origin and destination studies, Pedestrian studies; Parking studies, Vehicle detection methods; Advanced methods: GPS, Instrumented Vehicles, Image Processing, Bluetooth, Infrared methods.

- **TRAFFICFLOWANALYSIS (08 Hours)**
  Differences- heterogeneous and homogeneous traffic flows, Macroscopic, Microscopic & Mesoscopicapproach–TypesofFlow-Trafficstreamcharacteristics–Space–Timediagram– Relationship between speed, flow & Density-Highway capacity, Level of service & capacity analysis – mixed traffic flow behavior: Non-lane based movement, Heterogeneity, Applications.

- **INTERSECTIONDESIGN (09 Hours)**
  At-grade intersections- Principles of design – Design of Channelizing Islands and Roundabouts. Traffic signals - pre-timed and traffic actuated. Design of signal setting - phase diagrams, timing diagram – Signal co-ordination – Area traffic Control System. Grade separated interchanges their Warrants and Design Features.

- **ELEMENTS OF DESIGNANDREGULATIONS (10 Hours)**
  Geometric Design: Alignment-Crosssectionalelements-Stoppingandpassingsightdistance, Horizontal curves - Vertical curves. Design problems. Traffic regulation and control - Signs and markings-Traffic System Management, Speed, vehicle, parking, enforcement regulations, Bus Stop Location and Bus Bay Design, Design of Road Lighting. – Traffic Management techniques, one-way, tidal flow, turning restrictions etc. –TSM planning &Strategies.

- **TRAFFICSAFETY (05 Hours)**
  Principles and Practices – Safety along links - Safety at intersections. Road Safety Audit Countermeasures, evaluation of effectiveness of counter-measures– Road safety programmes.

(Total Lectures: 45hours)

3. Books Recommended

1. L R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi, 2002.
2. C J Khistyand L B Kent, Transportation Engineering-An Introduction, Prentice-Hall, New Jersey, 2005.
3. A D May, Traffic Flow Fundamentals, Prentice – Hall, Inc., New Jersey, 1990.
4. W R McShane, and R P Roess, Traffic Engineering, Prentice-Hall, New Jersey, 2010.
5. F L Mannering, and S S Washburn, Principles of Highway Engineering and Traffic Analysis, John Wiley and Sons, US, 2016.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	2	2	0	0	0	0	0	0	1
CO2	2	1	3	2	2	2	2	1	3	2	2	2
CO3	2	2	3	3	2	0	1	0	1	1	1	2
CO4	2	2	3	2	2	1	1	2	2	1	2	2
CO5	1	3	3	2	1	3	3	2	1	1	1	2

0- Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	1	1	2
CO2	2	3	3
CO3	3	3	3
CO4	2	3	3
CO5	2	2	3

0-Not related 1-Low 2-Moderate 3-High

CE 254 Town Planning

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Perceive significance of town with respect to legislation and administration.
CO2	Analyze urbanization growth with land use planning.
CO3	Implement different guidelines, norms, land use planning policies, and survey techniques.
CO4	Design of Housing Society based on development control regulations.
CO5	Appraise the urban infrastructure projects under various Government Scheme.

2. Syllabus

- **TOWN PLANNING CONCEPT, EVOLUTION & DEVELOPMENT (06 Hours)**
  Significance of town planning, Planning in Ancient, Medieval & Modern Periods, Contribution of noted urban planners, Planning legislation and administration.

- **URBAN SETTLEMENT CLASSIFICATION & STRUCTURE (06 Hours)**
  India's Urbanization, Growth theories, Urban form, Activity structure, Land use and density structure, Town classification, Multi-nuclei urban development.

- **TOWN COMPONENT (05 Hours)**
  Town Centre, Fringe Area, Impact of CBD on peripheral area development, issues and challenges of CBD and fringe area planning.

- **INDUSTRIES (02 Hours)**
  Types industries, Site selection criteria, environmental consideration.

- **PLANNING SURVEYS & APPLICATIONS (05 Hours)**
  Significance of surveys, Types, Planning parameters, Analysis and applications of Planning Surveys.

- **URBAN PLANNING & DESIGN (08 Hours)**
  Objectives & principals, Land use planning, Zonal planning, Neighbourhood planning, Development plan and control regulations, T.P. Scheme norms & methodology, New towns, Metro regions, Concept of Urban Design.

- **HOUSING** **(05 Hours)**
  Building Byelaws, Residential Area Planning, Income Groups, Building Forms and Density Pattern, Concept of Township, Neighbourhood, Special Area Planning.

- **URBAN INFRASTRUCTURES AND GOVERNMENT INITIATIVES (08 Hours)**
  Brief about Social and Physical Infrastructures, Transport Infrastructure, Importance and challenges in providing Water Supply, Drainage, Storm Water, Solid Waste Management and other infrastructures at city level, Issues at National and International level.

(Total Lectures: 45 hours)

3. Books Recommended

1. Modak N.V. and V.N. Ambdekar, "Town and Country Planning and Housing", Orient Longman Ltd., New Delhi. (1995)
2. Hiraskar G.K. "Fundamentals of Town Planning", Dhanpat Rai & Sons, Delhi (1993).
3. Gallion A., Eisner S., (2005), "The Urban Pattern: City planning and design", CBS Publishers and Distributors Pvt. Ltd, Delhi.
4. Ward S., (2002), "Planning the 20th Century City" John Willer & Sons.
5. Shivramakrishnan K. C., (2011), "Revisioning Indian Cities", Sage Publications.

4. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	2	2	2
CO3	3	3	3
CO4	3	3	3
CO5	2	3	3

-Not related 1-Low 2-Moderate 3-High

CE 256 Sustainable Building Planning

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Understanding of building typologies, climatology, historical planning and development
CO2	Review of sustainable building planning policies, implementation and innovative materials
CO3	Assessing the building performance by applying sustainable techniques
CO4	Evaluating residential and commercial building at neighbourhood level
CO5	Making business case

2. Syllabus

- **SUSTAINABLE PLANNING AND DEVELOPMENT (04 Hours)**
  Fundamentals of sustainability; Historical planning and development; Vernacular Architecture; climatic zones and parameters; Environmental impact on building cluster; Norms, guidelines, codes and policies; Stakeholder's role.

- **SUSTAINABLE BUILDING PLANNING (06 Hours)**
  Fundamentals of passive planning and design, climatology, thermal comfort, visual comfort and acoustic comfort, Minimization of natural resource utilization, Environment protection, site planning, energy conservation through planning and modeling, building technologies, indoor air quality, barriers to implementation of sustainable building measures.

- **GREATER EFFICIENCY (10 Hours)**
  Role of envelope, day light, daylight simulation, electric lighting and occupant behavior, thermal mass and Heat flow, thermal load, thermal simulation, heating cooling and ventilation (HVAC), role of planning and alternative material for reduction of operational energy in the building, life cycle cost, Net zero, Grid free, water & energy plus, checklist for sustainability, greater efficiency recommendations for sustainable buildings.

- **BUILDING PERFORMANCE ASSESSMENT (15 Hours)**
  Concept, tools at international and national level, Energy code ECBC requirement, NBC, Recent researches on sustainable building development, assessment tools – Open source, licensed software for performance assessment and energy compliance, Case studies of residential and commercial buildings.

- **GREEN SERVICES** **(06 Hours)**

  Climate and effect of built environment, Impact of urbanization on sustainability, Circular Economy through water and drainage network, Zero waste management, radiation budget, surface water balance, effect of trees and microclimate, modification through greening.

- **MAKING THE BUSINESS CASE** **(04 Hours)**

  Green building Evaluation Systems; LEED Certification; Green Certification, WGBC, GRIHA, IGBC, EDGE, ASSOCHAM and CPWD green rating, SBTool, process and certification.

(Total Lectures: 45 hours)

3. Books Recommended

1. Wheeler S. M. (2004), Planning for sustainability: creating livable, equitable and ecological communities, 2nd ed, Routledge, Taylor and Francis group, New York.
2. Maiellaro N. (2001), Towards sustainable building, Kluwer academic publishers, Netherlands.
3. "Sustainable building design manual: Sustainable building design practices" by The Energy and Resources Institute, New Delhi.
4. Takahiko Hasegawa T. (2003), Environmentally sustainable buildings: challenges and policies, Paris: Organisation for Economic Co-operation and Development, 2003.
5. Glavinich T.E., Contractor's Guide to Green Building Construction: Management, Project Delivery, Documentation, and Risk Reduction, Wiley; 2008 Lo C.P. & Yeung A.K.W. (2006), Concepts and Techniques of Geographic Information Systems, 2nd ed, Prentice Hall of India, New Delhi.

4. Mapping of COs and POs

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

0-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	3	3	2
CO2	1	2	2
CO3	2	3	3
CO4	1	1	2
CO5	1	2	3

0-Not related 1-Low 2-Moderate 3-High

CE 258 Regional Planning

L	T	P	C
3	0	0	3

1. Course Outcomes)COs(

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

CO1	Understand the concept of regional planning &development.
CO2	Recognize institutions and organization setup of regional authorities.
CO3	Identify the Requirement of resources for regional development.
CO4	Apply various theories for balanced regional development.
CO5	Prepare proposal on regional plan.

2. Syllabus

- **REGION AND REGIONAL DYNAMICS (10 Hours)**

  Region: Definition, Typology, classifications and Delineation of regions.

  Regional Dynamics: Growth of Mega and Metro Regions: Scale, Complexity and its impact on national and international scenario, convergence and divergence.

  Regional Economy, competitiveness among regions, backward and leading regions in development; Special Regions: SEZ, Agro Regions, Ecological regions, etc.

- **REGIONS IN INDIA AND ITS PLANNING)10 Hours(**

  Region in Indian Context: Resource Regions, Corridors as regions, National, subnational and State as a region, macro, meso and micro regions in India.
  Role of resources in regional development, utilization of resources and environmental problems Sectorial and regional development and imbalances, multilevel planning, special area development plans. Balanced developed development national and state level planning mechanism.
  Case Studies from India: NCR and Delhi Mega Region, Mumbai Mega Region, Greater Mumbai, Kolkata Metro Region, Chennai Metro Region, and other Metro Regions in India. Regional development planning in other countries. Special region plans.
  Resource Regions in India: Western and Eastern Ghats, North Eastern Region, Coastal Regions, and River Valley Regions; Corridors: Golden Quadrilateral, Delhi-Mumbai, Chennai-Bangalore Industrial Corridor, North-South and East-West Corridor Regions.

- **CORE AND PERIPHERY IN A REGION IN INDIAN CONTEXT (08 Hours)**

  Core, Fringe and Periphery in a Region and its planning; Tools and techniques available for planning regions in India; Role of 73rd and 74th Constitution Amendment Acts in regional plan Preparation and implementation. Concept of District Planning.

- **ELEMENTS OF MICRO AND MACRO ECONOMICS (08 Hours)**

  Basic Economics: Demand, Supply, Elasticity, Revenue Cost, National Income, Consumption, Investment, Inflation, Capital Budgeting.

Development Economics: Economic Growth and development, Human Development Index, Economic Principles, Policies and strategies in Land use planning.

- **TECHNIQUES AND GROWTH MODELS OF REGIONAL ANALYSIS (09 Hours)**

Regional Analysis: Introduction to regional analysis, regional linear programming, regional input-output analysis, factor analysis, industrial location theory, spatial diffusion theory, gravity analysis.

GROWTH MODELS: Concept of Growth pole and growth foci, core-periphery concept, role of settlements in regional development, urbanisation and regional development, input – output models, central place theory Christaller Loseh.

(Total Lectures: 45 Hours)

3. References

1. Sundaram K. "Urban and Regional Planning in India", New Delhi: Vikas Publishers
2. Chaudhuri, Jayasri R. "An Introduction to Development and Regional Planning", Kolkata: Orient Longman Ltd, 2001
3. Jiwan J. "Regional Development and Planning", Rawat Publications, 2021
4. Allen. N. "Regional Development and Planning for the 21st Century: New Priorities, New Philosophies", Routledge
5. Kanan. C. "Regional Planning: Concept Theory and Practice", Concept Publishing Company, 2017

4. CO-PO_Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	0	0	0	0	2	1	1	1	0	1
CO2	0	1	0	0	1	1	2	1	0	1	1	1
CO3	2	2	1	2	3	0	1	1	2	0	2	2
CO4	2	1	2	2	3	1	2	2	0	0	2	2
CO5	3	3	3	3	3	1	3	1	2	1	3	3

0-Not related 1-Low 2-Moderate 3-High

5. CO-PSO_Mapping

	PSO1	PSO2	PSO3
CO1	2	1	0
CO2	1	0	0
CO3	3	1	3
CO4	3	2	2
CO5	3	3	3

0-Not related 1-Low 2-Moderate 3-High

CE 262 Channel Hydraulics

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Analyse uniform flow in open channels
CO2	Analyse non-uniform flow in open channels
CO3	Analyse spatially varied flow
CO4	Analyse unsteady flow in channels
CO5	Apply numerical methods for unsteady flow calculations

2. Syllabus

- **UNIFORM FLOW** **(10 Hours)**
  Specific energy, Specific energy curve and its limitations, critical depth and section factor for critical flow computations, open channel flow transitions, standing wave, venture flumes, control sections and hydraulic exponent for critical flow computations.

- **NON-UNIFORM FLOW** **(10 Hours)**
  Rapidly varied flow, specific force curve and its application in the analysis of hydraulic jump, hydraulic jump characteristics Assumptions in GVF analysis, dynamic equation of GVF, classification of channel slopes, GVF profiles, its identification and computation, applications.

- **SPATIALLY VARIED FLOW** **(8 Hours)**
  Basic principles and assumptions, differential equations, analysis of flow profiles and flow through side weirs and bottom racks.

- **UNSTEADY FLOW** **(09 Hours)**
  Waves, classification of waves, waves celerity, occurrences of unsteady flow, height and celerity of gravity waves, governing equations for one dimensional flow, St. Vennant equation and numerical methods.

- **UNSTEADY FLOW NUMERICAL METHODS** **(08 Hours)**
  Method of characteristics, Finite difference methods, explicit and implicit finite difference schemes, consistency, stability.

(Total Lectures: 45 hours)

3. Books Recommended

1. G L Asawa, “Fluid Flow in Pipes and Channels”, CBS Publishers, New Delhi, 2014.
2. H M Chaudhary., Open Channel flow, Prantice-Hall of India Pvt. Ltd. New Delhi, 1993.
3. V T Chow, Open Channel Hydraulics, McGraw-Hill Book Company, International editions, New Delhi, 1973.
4. K Subramanya, Flow in open channels, Sixth edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2001.
5. R Srivastava , Flow through open channels, Oxford Higher Education, Oxford University Press, Jericho, 2007.

4. Mapping of COs and POs

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

-Not related 1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	2	1	1
CO2	1	1	1
CO3	1	1	1
CO4	1	1	1
CO5	1	1	1

-Not related 1-Low 2-Moderate 3-High