

Teaching and Examination Syllabus

of

Bachelor of Technology (2nd Year)

in

Civil Engineering



Department of Civil Engineering

Sardar Vallabhbhai National Institute of Technology, Surat

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 PUMPS (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 various 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

CE 251 Engineering Geology

| L | T | P | C |
|---|---|---|---|
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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 252 Railway Engineering

| L | T | P | C |
|---|---|---|---|
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1. Course Outcomes (COs)

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

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|-----|--|
| 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-SPEED 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 256 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 257 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; Hierarchical 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

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

CE 202 Concrete 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 | 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 Guniting.

(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*:

1. Measurement of Vertical Angle with Vernier Theodolite
2. Measurement of Vertical Angle with Digital Theodolite
3. Determination of Tacheometric constant K and C
4. Tacheometric Exercise with stadia method
5. Tacheometric Exercise with tangential method
6. Determination of horizontal distance by subtense bar method
7. Contour Survey by radial method using Tacheometer
8. Determination of strength of triangulation Figure.
9. Exercise on Triangulation Work without satellite Station
10. Exercise on Triangulation Work including satellite Station
11. Adjustment of Triangles Closure and Station closure.
12. Setting out of circular Curve by Offsets from the Long Chord
13. Setting out of circular Curve by Rankine (Deflection Angle) Method
14. Application of Solution of Three Point Problem for locating the position of boat on map

****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)

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. Clerk 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

CE 253 Airport 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 | 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 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 255 Building For Greater Efficiency

| 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 |

-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 |

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

CE 258 Advanced Surveying

| 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 | Analyze computation and measurement of relief displacement, development of mosaic etc. using principle of photogrammetry |
| CO2 | Compute and detail Azimuth, Declination etc. of celestial bodies using principle of astronomy |
| CO3 | Analyze the problem and its remedial measures pertaining to hydrographic Survey |
| CO4 | Explain the concept of EDM and Total Station Survey |
| CO5 | Explain advanced surveying techniques of Terrain Data Collection including ALTM, LIDAR, DEM |

2. Syllabus

- **PHOTOGRAMMETRIC SURVEY (12 Hours)**
Introduction, Technical terms, Aerial photogrammetry, Types of photographs, Vertical photographs, Uses of aerial photographs, Flying height & scale, Relief displacement, Stereoscopy, Measurement of parallax and height determination, Mosaic preparation.
- **PRINCIPLES OF FIELD ASTRONOMY (10 Hours)**
Introduction, purposes, astronomical terms, determination of azimuth, latitude, longitude and time corrections to the observations.
- **HYDROGRAPHIC SURVEYS (8 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.
- **EDM AND TOTAL STATION SURVEY (08 Hours)**
General Process of EDM, Principle of EDM, Electromagnetic Waves, Phase and Types of Waves, Distance Measurement by Transit time and by Phase difference, Electro-optical, Infrared and Microwave, Total Station – Function and Process, Applications, Sources of Errors.

- **TERRAIN DATA COLLECTION** **(07 Hours)**
Airborne laser thematic mapper (ALTM), LIDAR, Profiles, Digital Elevation Models.

(Total Lectures: 45 hours)

3. Books Recommended

1. W. Schofield, "Engineering Surveying", Butterworth-Heinemann Publication, New Delhi (2001)
2. Punmia B.C., "Surveying and Levelling, Vol. II & III", Laxmi Publications Pvt. Ltd., New Delhi (1994)
3. Arora K.R., "Surveying and Levelling, Vol. III", Standard Publications, Delhi (2000).
4. Lillesand T. M. and Kiefer R. W., "Remote Sensing and Image Interpretation", 4th Edition, John Wiley and Sons, New York, (2002).
5. Agrawal N.K., "Essentials of GPS" Spatial Network Pvt. Ltd., Hyderabad (1997).
6. Stan Aronoff, "Geographic Information Systems: A management perspective", WDL Publications, Canada, (1989).

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 259 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