Sardar Vallabhbhai National Institute of Technology

Teaching Scheme and Syllabus

for

Bachelor of Technology

in

Civil Engineering

3rd Year (5th and 6th Semester)

Department of Civil Engineering

CE 301 Design of Steel Structures

L	T	P	C
3	0	2	4

Course Outcomes (COs)

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

CO1	Evaluate steel as building material, and composition of steel
CO2	Illustrate IS Codes, different loads and combination of loads, design philosophy
CO3	Analyse design philosophy for creating steel structure members (Design of tension, compression, flexure members), connections etc.
CO4	Apply knowledge for design of various structural members.
CO5	Analyse and design of various industrial structures

Syllabus

- **INTRODUCTION (08 Hours)**
  Introduction, Iron and steel in India, Chemical composition of steel, Mechanical properties of steel, Residual stresses, Stress concentration, High-performance steel, Advantages of steel as a structural material, Role and responsibilities of a designer, Structural systems, Analysis and design, Codes and specifications.

- **DESIGN PHILOSOPHY, LOADING & LOAD COMBINATIONS (06 Hours)**
  Design Philosophies, Limit State Method, Failure criteria for steel, Introduction to loading, Characteristic actions, Dead loads, Imposed loads, Temperature effects, Hydrostatic and soil pressure, Erection loads, Accidental loads, Wind loads, Other pattern loading.

- **CONNECTIONS (08 Hours)**
  Introduction to connections, Design of Bolted Connections, Design of Welded Connections.

- **DESIGN OF TENSION MEMBERS (06 Hours)**
  Introduction to Tension members- Types, Behaviour, Slenderness Ratio, Modes of failure, Design of Tension member.

- **DESIGN OF COMPRESSION MEMBERS (06 Hours)**
  Introduction to Compression members- Possible failure modes, Behaviour, Effective length, Types of section, Design of axially loaded compression members.

- **DESIGN OF BEAM (08 Hours)**
  Introduction- Types of sections, Lateral Stability of Beams, Effective length of beams, Buckling Behaviour of beam, Bending and shear strength of beams, Web crippling, Design procedure of Rolled Beams

- **DESIGN OF COLUMN BASES AND CAPS (03 Hours)**
  Introduction- Types of Column Bases-Slab Base-Gusset Base, Design of Moment-Resistant Base Plate, Foundation Bolts

(Total Lectures: 45 hours, Practical: 30 hours)

Practicals

1.Design of Office/Residential steel multi-storeyed building
2.Design of Industrial roof with entire necessary infrastructure

Books Recommended

1. N Subramanian, Steel Structure Design Practice, Oxford Press, Oxford, 2013.
2. SK Duggal, Design of Steel Structure. 3rd Edition, Tata Mc Graw Hill Publication, New Delhi, 2007.
3. P Dayaratnam, Design of Steel Structures, S. Chand and Company, Delhi, 2003.
4. S.S. Bhavikatti, Design of Steel Structures, I K International Publishing House, Delhi, 2009
5. V.L. Shah and S.R. Karve, Limit state Design of Steel Structures, Structures Publications, Pune, 2019

Mapping of COs and POs

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

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

Mapping of COs and PSOs

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

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

CE 303 Structural Analysis

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 displacements and internal forces of statically indeterminate beams by classical, iterative and matrix methods
CO2	Analyze Axial force, Shear force and Bending moment in frames subjected to lateral loads using approximate methods
CO3	Analyze internal forces and reactions for two hinged and three hinged arches
CO4	Analyze steel structure using Plastic design concept
CO5	Determine internal forces and reactions in indeterminate beams subjected to moving Loads using influence lines.

2. Syllabus

- **ANALYSIS OF INDETERMINATE BEAMS (05 Hours)**
  Concept of fixed and propped cantilever beams
- **ANALYSIS OF INDETETERMINATE STRUCTURES WITH DISPLACEMENT BASED METHODS (12 Hours)**
  Slope Deflection Method – Moment Distribution method for continuous beam and rigid frame with and without support settlement; with and without sidesway
- **ANALYSIS OF THREE AND TWO HINGED ARCHES (08 Hours)**
  Parabolic and Circular Arch with Support at same and different level - Influence line of Arches
- **APPROXIMATE METHODS OF ANALYSIS (03 Hours)**
  Cantilever Method and Portal Method
- **MATRIX METHOD OF ANALYSIS (08 Hours)**
  Introduction to force and displacement method of analysis-stiffness method of analysis using direct element approach
- **PLASTIC ANALYSIS OF STRUCUTRE (05 Hours)**
  Plastic hinge concept. Shape factor-Static and kinematic method for beams and frames with portal and sway mechanism
- **ANALYSIS FOR MOVING LOADS FOR INDETERMINATE BEAMS (04 Hours)**
  Construction of influence line for beams, Application of Mueller Breslau Principle

(Total Lectures: 45 hours)

3. Tutorials

The students will be required to solve at least five examples related to theories from each topic as part of their assignment or tutorial. This will help to solve real-life problems and hands on practice for analysis of civil engineering structures.

(Total Tutorials: 15 hours)

4. Practical

1. Introduction to computer aided analysis and overview of STAAD-Pro. Connect edition
2. Features of STAAD-Pro Connect edition, axis (local and global) and sign conventions, steps for static analysis
3. Analysis of cantilever, simply supported and overhang beam
4. Analysis of fixed and propped cantilever beams

5. Analysis of continuous beams
6. Analysis of continuous beams with varying stiffness along length and
7. subjected to support rotation and settlement
8. Analysis of portal Frames
9. Analysis of portal Frames with varying stiffness along length and
10. Subjected to support rotation and settlement
11. Analysis of plane (2D) truss (Determinate and Indeterminate)
12. Analysis of space (3D) truss
13. Analysis of 3 hinged and 2 hinged arches with various boundary conditions
14. Analysis of beams subjected to moving loads
15. Design of steel beam, truss and column as per Indian codes

5. Books Recommended

1. C S Reddy, Basic Structural Analysis, 3rd Edison, Tata Mc Graw Hill, New Delhi, 2017.
2. R C Hibbler, Structural Analysis, 11th Edison Pearson, New Delhi, 2023.
3. A S Meghere and S K Deshmukh, Matrix method of Structural Analysis, Charotar Publishing House, Anand, 2020.
4. S S Bhavikatti, Structural Analysis- II, 5th Edison, Vikas Publishing, Noida, 2021.
5. Aslam Kassimali, Structural Analysis, 5th Edison Cengage Publications, Delhi, 2015.

5. Mapping of COs and POs

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

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

6. Mapping of COs and PSOs

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

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

CE 305 Transportation System Design

L	T	P	C
3	1	0	4

Course Outcomes (COs)

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

CO1	Describe the concept of transportation systems and the challenges involved therein
CO2	Comprehend the basic principles of highway geometric design in the context of transportation engineering and planning
CO3	Comprehend the basics of various transportation structure including Docks and Harbours.
CO4	Apply design criteria for the geometric design of different roadway elements.
CO5	Apply planning and design of airports and railway track elements design.

Syllabus

- **UNIT 1: Introduction to Transport Systems (03 HOURS)**
  Introduction to the transportation systems, the role of transportation systems in development of the societies, issues and challenges faced by different transportation systems, Opportunities for transportation specialists in the transportation sector, the historical developments and the current state of the modes.

- **UNIT 2: Framework for Design of Transport Facilities (04 HOURS)**
  Broad steps and framework involved in the design of transport facilities. Available guidelines from Ministry of Housing and urban affairs (MoHUA), Ministry of Road Transport and Highways (MoRTH) and Indian Roads Congress (IRC), Case Studies

- **UNIT 3: Basics of Highway and Geometric Design (08 HOURS)**
  Highway cross section elements, sight distance characteristics of highways, numerical problems, design of horizontal alignment- super elevation, transition curves, extra widening, numerical problems, design of vertical alignment-grades and grade compensation, types of vertical curves and design numerical problems, highway drainage.

- **UNIT 4: Design concept of Pavements (08 HOURS)**
  Types of Pavements, Basic characteristics of materials used in pavements, Variables considered in pavement design, Classification of axle types, standard and legal axle loads, tyre pressure, contact pressure, ESWL, EWLF and EAL concepts, Traffic analysis: ADT, AADT, truck factor, growth factor, lane distribution factor, directional distribution factor and vehicle damage factor. Design concept of flexible and rigid pavements. Layered system concepts; Stresses in Rigid Pavement. Basic introduction of IRC codes and practice.

- **UNIT 5: Basics of Railway Track Engineering and Design (06 HOURS)**
  Railway track gauge, alignment and surveys, stresses in tracks, rails, sleepers and ballast, subgrade and formation, track fittings and fastenings, creep of rail and geometric design of track.

- **UNIT 6: Basics of Airport Engineering and design (04 HOURS)**
  Aircraft characteristics related to airport design, Airport classification, runway orientation: wind rose diagram, runway length, runway system spacing, taxiways and aprons.

- **UNIT 7: Transportation Structures (06 HOURS)**
  Types – Culverts, Bridge, fly-overs, tunnels, components, classification, requirements, site selection, alignment, bridge sub structure, Bridge Super Structure – Super structure elements, bridge flooring, slab bridges and girder bridges, bridge bearings, joints in bridges, piers, abutments, wing walls and approaches.

- **UNIT 8: Docks and Harbours (06 HOURS)**
  Harbours and Ports: Classification of ports, requirements of a good port, classification of harbour, harbor planning, requirements of harbour, Docks and Spillways - Introduction, advantages of docks, moles, shape of docks and basins, dock entrance, entrance docks, quays, jetties and wharves, tide, wind and wave, dry dock, types of breakwaters.

(Total Lectures: 45 hours, Tutorials: 14 hours)

1. Books Recommended

1. J.H. Banks, Introduction to Transportation Engineering, McGraw-Hill, New York.
2. C.S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, 3rd Ed., Prentice Hall, New Jersey.
3. Fred L. Mannering, Scott S.Washburn and Walter P.Kilareski; Principles of Highway Engineering and Traffic Analysis, Wiley India.
4. S. K. Khanna., C. E. G. Justo and A. Veeraragavan; Highway Engineering- Nem Chand Bros, India.
5. Satish Chandra, M.M.Agarwal; Railway Engineering, Oxford University Press, New Delhi, India.
6. Norman J. Ashford, Saleh Mumayiz, Paul H. Wright; Airport Engineering: Planning, Design and Development of 21st Century Airports, Wiley, New Jersey, USA
7. Robert Horonjeff, Francis X. McKelvey, William J. Sproule, Seth B. Young; Planning and Design of Airports, McGraw-Hill Companies, New York, USA.
8. S P Bindra, Bridge Engineering, Dhanpat Rai and Sons, New Delhi, 2012.
9. R. Srinivasan Harbour Dock and Tunnel Engineering, Charotar Publishing, 2016.

CODES

1. **IRC: 37-2018***Guidelines for the Design of Flexible Pavements*, The Indian Roads Congress, New Delhi, India, 2018.
2. **IRC:58-2015***Guidelines for the Design of Plain Jointed Rigid Pavements for Highways*, The Indian Roads Congress, New Delhi, India, 2015.

Mapping of COs and POs

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

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

Mapping of COs and PSOs

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

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

CORE ELECTIVE/ ELECTIVE 3

5th Semester- 3rd Year UG

CE 331 Heavy Construction Technology

L	T	P	C
3	1	0	4

6. Course Outcomes (COs)

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

CO1	Understand the theories and techniques of heavy foundation construction.
CO2	Apply modern techniques for special construction.
CO3	Implement prefabricated construction technologies.
CO4	Design and apply advanced formwork and scaffolding systems.
CO5	Execute tunnelling, steel and bridge construction projects using appropriate methods and tools.

7. Syllabus

- **CONSTRUCTION OF HEAVY FOUNDATIONS (08 Hours)**
  Fundamental theories of heavy foundations, deep foundation theories, design concepts of deep foundation, types of heavy foundations, pile foundation, modern piling technology, pile driving machineries, sheet piling, well and caisson, cofferdams and raft foundation, techniques of box jacking, pipe jacking, under water construction of diaphragm walls and basement, construction techniques of heavy foundation, safety during construction of heavy foundation, resource planning for heavy foundation construction.

- **SPECIAL CONSTRUCTION (06 Hours)**
  Special concrete like high performance, self-compacting etc., construction procedure of modern construction techniques of box pushing technology, advanced types of retaining walls, diaphragm walls, dewatering techniques and design of dewatering system, surface finishing materials techniques and advanced curing technologies.

- **PREFABRICATED CONSTRUCTION TECHNOLOGIES (08 Hours)**
  Planning for pre-casting, selection of equipment for fabrication, transport and erection, quality measures, safety measures during erection, different techniques of pre-tensioning and post-tensioning. concepts of rebar detailing software, 3D modelling, reinforced concrete-based technologies, precast concrete technology, monolithic concrete structure with aluminium formwork, structural steel-based technologies, pre-engineered building (PEB) technology, light gauge steel frame structure (LGSF) technology, expanded polystyrene (EPS) technology, other technologies-glass fibre reinforced gypsum (GFRG) technology, wood house technology, polypropylene honeycomb panels technology, polyurethane foam (PUF) panel technology, automated fabrication at site.

- **FORMWORK (05 Hours)**
  Requirement of formwork, loads carried by formwork, types of formworks such as timber formwork, steel formwork, patent formwork, modular shuttering, slip forms and other moving forms, steel scaffolding. shoring, reshoring and back shoring in multi-storeyed building construction.

- **TUNNELLING (08 Hours)**
  Tunnelling methods: types and purpose of tunnels; factors affecting choice of excavation technique; methods – soft ground tunnelling, hard rock tunnelling, shallow tunnelling, deep tunnelling; shallow tunnels – cut and cover, cover and cut, pipe jacking, jacked box excavation techniques, methods of muck disposal, supporting, problems encountered in tunnelling and remedial measures, tunnelling by drilling and blasting: drilling – drilling principles, drilling equipment, drilling tools, drill selection; blasting – explosives, initiators; types of cuts- fan, wedge and others; mucking and transportation equipment selection; NATM, TBM.

- **STEEL CONSTRUCTION (05 Hours)**
  Planning for field operations, selection of equipment and erection tools, tools and methods of welding, tools and methods of cutting and joining, bridge erection: transportation of girders, quality measures, safety measures during fabrication and erection, bar bending schedules and bar cutting & bending machines.

- **BRIDGE CONSTRUCTION (05 Hours)**
  Components of bridge, types of bridge, bridge construction including segmental construction, incremental construction and push launching techniques, box pushing method, top to bottom construction.

(Total Lectures: 45 hours)

8. Books Recommended

1. R E Smith, Prefab Architecture: A Guide to Modular Design and Construction, John Wiley and Sons, Hoboken, 2010.
2. R Chudley and R Greeno, Advanced Construction Technology, Pearson Education, Harlow, 2006.
3. G Beer, Technology Innovation in Underground Construction, CRC Press, London, 2009.
4. R L Peurifoy and G D Oberlender, Formwork for Concrete Structures, McGraw-Hill Professional, 4th Edition, 2010.
5. J O Bickel, T R Kuesel and E H King, Tunnel Engineering Handbook, Springer, 2011.
6. W Chen and L Duan, Bridge Engineering Handbook, CRC Press, 1999.

9. Mapping of COs and POs

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

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

10. 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

CE333 Solid and Hazardous Waste 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	Explain solid and hazardous waste management issues and its legal aspects.
CO2	Characterize and quantify solid and hazardous waste.
CO3	Analyse collection, transportation and processing of waste management system.
CO4	Design disposal and treatment facility for solid and Hazardous waste
CO5	Develop waste management facility for bio medical, plastic, E-waste etc.

2. Syllabus

- **INTRODUCTION (05 Hours)**

  Solid waste sources – Nature and characteristics – Quantities and Qualities – Generation rates – Potential of disease – Nuisance and other problems.

- **COLLECTION AND STORAGE (10 Hours)**

  Solid waste management – Functional elements of solid waste–on–site storage –Collection and separation – Containers and its location – Collection systems and its example – physical , chemical and microbiological characteristics of waste – Vehicle routing – Route balance – Transfer station – Processing – Recovery and reuse.

- **PROCESSING OF MUNICIPAL SOLID WASTE (10 Hours)**

  Conveying and compacting waste – Shredding – Types of shredders – Shredders Design–Material separation – Types – Devices for material separation – Thermal processing of municipal solid waste – incinerator and pyrolysis – Refuse Drived fuel – Biological process like composting , vermi composting and biomethanation

- **DISPOSAL (10 Hours)**

  Disposal methods – Sanitary land filling – Planning – Site selection – Design – Landfill Process – Monitoring Closure – Post closure monitoring – Other methods like incineration, pyrolysis, and composting, biological digestion.

- **HAZARDOUS WASTE MANAGEMENT (10 Hours)**

  Introduction to hazardous waste – Definition – Characterization and composition – TCLP test – Storage and transportation of hazardous waste – Labeling of hazardous waste – Physical, Chemical and Biological treatment of hazardous waste – Bioremediation of hazardous waste – Treatment of Bio medical – Nuclear waste and Radio – Active waste – Fly ash management and E-waste management

(Total Lectures: 45 hours)

3. Books Recommended

1. G Tchobanoglous and F Kreith, Handbook of Solid Waste Management, McGraw-Hill, New York, 2002.
2. H S Peavy and G Tchobanoglous, Environmental Engineering, McGraw Hill, New Delhi, 2004.
3. CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2016.
4. R J Watts, Hazardous Wastes - Sources, Pathways, Receptors, John Wiley and Sons, New York, 2008.
5. J Pichtel, Waste Management Practices, CRC Press, New York, 2005.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 335 Advanced Geotechnical 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	Classify the various soil exploration and stabilization methods
CO2	Analyze the slope stability and lateral earth pressure
CO3	Evaluate the load carrying capacity and settlement of shallow foundation
CO4	Analyse the soil condition and design retaining wall & foundation system
CO5	Evaluate the load carrying capacity of pile foundation

2. Syllabus

- **GEOTECHNICAL INVESTIGATION** **(04 Hours)**
  Sub soil exploration by Geo Physical methods – Seismic method, Electrical resistivity method – Borelog sheet– Sub soil Investigation report.

- **LATERAL EARTH PRESSURE** **(05 Hours)**
  Definition - Active - Passive and Earth pressure at rest conditions, Rankine's theory for cohesionless and cohesive soil - Lateral Earth Pressure Due to Surcharge, Inclined backfill - Coulomb's theories of earth pressure - Graphical Method

- **RETAINING SYSTEM** **(07 Hours)**
  Types of retaining systems. **Retaining wall**: Types of Retaining Walls, Application of Lateral Earth Pressure Theories to Design and Stability of Retaining Walls, **Sheet-Pile Walls**: Cantilever Sheet-Pile Walls in sand, clay and layered soil, Anchored Sheet-Pile Walls, Free Earth Support Method for Penetration of Sandy and Clayey Soil, Holding Capacity of Anchor Plates in Sand and Clay

- **STABILITY OF SLOPE** **(08 Hours)**
  Types of slope failures-Different factors of safety-Infinite slope - Finite slope –Wedge failure- - Analysis of Finite Slopes with Plane Failure Surfaces and with Circular Failure Surfaces - Bishop's Simplified Method of Slices - Taylors stability number- Swedish method-Applications to design of earth dam, choice of shear parameters - Total and effective stress analysis - Slope protection and stabilization.

- **BEARING CAPACITY OF SOIL** **(04 Hours)**
  Introduction – Basic definitions – Bearing capacity theories – Types of shear failure – Effect of water table – Bearing capacity from field tests - plate load test, Penetration tests.

- **FOUNDATION SETTLEMENT** **(04 Hours)**

Settlement of Foundations – Components of Settlement – Cause of Settlement – Computation of Immediate settlement– Computation of magnitude of consolidation settlement – Time rate settlement – Differential settlement.

- **DESIGN OF SHALLOW FOUNDATIONS** **(04 Hours)**

  Types of Shallow Foundations – Depth of Footing – Foundation loading – Principle of design of footings – Proportioning for equal settlement – combined footings –mat foundation.

- **DEEP FOUNDATIONS** **(06 Hours)**

  Deep foundations – Necessity of pile foundation – Classification of piles – Load carrying capacity of piles – Pile load test – Negative skin friction – Settlement of pile – Group efficiency, Introduction of caisson and well foundation

- **INTRODUCTION TO SOIL STABILIZATION** **(03 Hours)**

  Mechanical Stabilization – cement Stabilization – Lime Stabilization –Bituminous Stabilization – Chemical Stabilization– Stabilization by geosynthetics

(Total Lectures: 45 hours)

3. Books Recommended

1. J E Bowles, Foundation Analysis and Design, Tata McGraw-Hill, New Delhi, 1997.
2. K R Arora, Soil Mechanics and Foundation Engineering, Standard Publishers Distributors, Nai Sarak, Delhi, 2008.
3. B M Das, & N Sivakugan, Principles of Foundation Engineering, Cengage learning, Boston, 2018.
4. D P Coduto, M R Yeung, & W A Kitch, Foundation Design: Principles and Practices, 3rd Ed, Pearson Education, USA, 2016.
5. S R Kaniraj, Design Aids in Soil Mechanics and Foundation Engineering, Tata McGraw-Hill, New Delhi, 2009.
6. R Gopal, & A S Rao, Basic and Applied Soil Mechanics, New Age International Publishers, New Delhi, 2011.

4. 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

5. 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 337 Advanced Concrete 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	Explain the cement hydration and its microstructure development.
CO2	Design the special concrete and its mix design procedure.
CO3	Apply the Rheometers and corrosion analyzer systems for measurement in fresh and
CO4	hardened concrete properties
CO5	Analyze the various durability related problems in reinforced concrete and its mitigation.

2. Syllabus

HYDRATION AND MICRO-STRUCTURE OF CEMENT (10 Hours)

Hydration of Cements and Micro-structural development, Mineral additives, Chemical admixtures, Cracking and Volume stability, Deterioration processes, Special concretes, Advanced Characterization Techniques, Sustainability issues in concreting, Modeling properties of concrete.

PARTICLE PACKING AND RHEOLOGY (15 Hours)

Advanced Mixture Design, Design Philosophy - Particle Packing & Rheology - Discrete and Continuous approach, Packing density of powders and aggregates - Experimental tests and Models, Ternary Packing Diagram, Mixture Design of Self - Compacting Concrete (SCC); Fresh Concrete Properties, Empirical test for SCC – Rheology, Basics, Parameters, Models, Rheometers, Rheology of Paste and concrete – Pumping, Setting, Curing, Plastic shrinkage, Strength Development, Maturity Method; Hardened Concrete Properties, Factors influencing strength, Interfacial Transition Zone, Stress strain relationship –Localization, End effects, Loading Conditions; Dimensional Stability, Creep and Shrinkage

DURABILITY ASPECTS OF CONCRETE (10 Hours)

Durability, Permeability and Porosity, Chemical attack (Sulphate attack, Delayed Ettringite Formation, Chloride attack, Acid Attack, Sea Water attack, Carbonation, Freezing and Thawing, Alkali aggregate reaction, Alkali carbonate reaction Corrosion, Mode of action, failure, Tests& Protection methods.

REBAR CORROSION (10 Hours)

Rebar Corrosion, Factors inducing rebar corrosion, electrochemical process, role of chloride in corrosion, role of carbon-di-oxide in corrosion, onset of corrosion, corrosion propagation, and service life prediction of concrete structures.

(Total Lecture Hours: 45, Tutorial 15 Hours)

3. Tutorials

Tutorials will be given related to mix proportioning by different methods such as IS Code, ACI method, British DOE methods

4 Books Recommended

1. P Kumar Metha and P J M Monterio, Concrete- Microstructures, Properties and Materials,Indian Edition, McGraw-Hill Publication, New Delhi, 2016.
2. P C Aitcin, High Performance Concrete, E&FN Spon, London, 2019.
3. A R Santhakumar, Concrete Technology, Oxford University Press, New Delhi, 2017.
4. A M Neville, and J J Brooks, Concrete Technology, Pearson Education Ltd., Singapore, 2012.
5. K Kalliopi. Aligizaki, Pore Structure of Cement-Based Materials: Testing, Interpretationand Requirements, CRC Press, 2005.

5. Mapping of COs and POs

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

1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

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

1-Low 2-Moderate 3-High

	L	T	P	C
CE339 PAVEMENT ANALYSIS AND DESIGN	**3**	**1**	**0**	**4**

Students will be able to
CO1: Comprehend the behaviour of pavement based on material characteristics.
CO2: Analyse the pavement by considering various input parameters appropriately.
CO3: Select the rational method of pavement design.
CO4: Identify the design criteria based on the major failure patterns of pavement.
CO5: Design the pavement with the guidelines given by IRC, AASHTO, and PCA.

- **PAVEMENT TYPES AND MATERIALS (03 Hours)**
  Types and component parts of pavements; highway and airport pavements, Basic characteristics of materials used in pavements

- **STRESSES IN FLEXIBLE PAVEMENTS (08 Hours)**
  Layered system concepts, Stress solution for one, two- and three-layered systems, Fundamental design concepts, Stress analysis in flexible pavements using KENLAYER; problems

- **STRESSES IN RIGID PAVEMENTS (06 Hours)**
  Westergaard's theory and assumptions, Stresses due to curling, stresses and deflections due to loading, frictional stresses, Stresses in dowel bars and tie bars, Stress analysis in rigid pavements using KENSLABS; problems.

- **FACTORS AFFECTING PAVEMENT DESIGN (06 Hours)**
  Variables considered in pavement design, Classification of axle types, standard and legal axle loads, tyre pressure, contact pressure, ESWL, EWLF and EAL concepts, Traffic analysis: ADT, AADT, truck factor, growth factor, lane distribution factor, directional distribution factor and vehicle damage factor

- **DESIGN OF FLEXIBLE PAVEMENT (09 Hours)**
  IRC method of flexible pavement design, Asphalt Institute's methods with HMA and other base combinations, MEPDG method of flexible pavement design, Design of flexible pavement shoulders; problems.

- **DESIGN OF RIGID PAVEMENTS (09 Hours)**
  IRC method of plain jointed and continuously reinforced rigid pavement design , MEPDG method of rigid pavement design, Design of rigid pavement shoulders. Design of Joints; problems.

- **DESIGN OF PAVEMENT DRAINAGE (04 Hours)**
  Detrimental effects of water, methods for controlling water in pavements, Drainage materials: aggregates, geotextiles, pipes, Estimation of inflow, determination of drainage capacity, Drainage design for urban roads and rural roads as per IRC; problems

(Total contact hours: 45)

REFERENCES:

1. **Huang, Y.H.** *Pavement Analysis and Design*, Second Edition, Dorling Kindersley (India) Pvt. Ltd., New Delhi, India, 2008.
2. **Mallick, R.B.** and **T. El-Korchi***Pavement Engineering – Principles and Practice*, CRC Press, Taylor and Francis Group, Florida, USA, 2009.
3. **MEPDG-1.***Mechanistic-Empirical Pavement Design Guide - A Manual of Practice*, Interim Edition, American Association of State Highway and Transportation Officials, Washington, D.C., USA, 2008.
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.

CODES

3. **IRC: 37-2018***Guidelines for the Design of Flexible Pavements*, The Indian Roads Congress, New Delhi, India, 2018.
4. **IRC:58-2015***Guidelines for the Design of Plain Jointed Rigid Pavements for Highways*, The Indian Roads Congress, New Delhi, India, 2015.

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

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

CE 341 Urban Transport Planning

L	T	P	C
3	0	0	3

11. Course Outcomes (COs)

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

CO1	Paraphrase urbanization process and its impact on travel demand
CO2	Explain the urban transport planning process and specify transport planning surveys for the given problem
CO3	Perform trip generation and distribution analysis for a given study area
CO4	Apply mode share models and carry out traffic assignment for a given study area
CO5	Apply land use transport model and estimate fleet size and capacity for suitable urban transit system

12. Syllabus

- **URBANISATION PROCESS** **(03 Hours)**
  Urban growth mechanism- Urban morphology - Urbanization & travel demand - Urban development planning policy- NUTP - Urban transport projects - Urban transport problems in India.

- **URBAN TRANSPORT PLANNING PROCESS** **(04 Hours)**
  Urban travel patterns - Study area delineation- Zoning - Planning surveys - Urban activity system- Sustainable urban transport - Systems approach.

- **TRAVEL DEMAND ESTIMATE** **(04 Hours)**
  Trip based and activity based approach - Four stage travel demand modelling - Data needs and outputs - Quick response techniques - Survey designs.

- **TRIP GENERATION** **(04 Hours)**
  Productions & Attractions - Influential Factors Trip rate analysis -Category analysis- Simple & Multiple linear regression models FHWA method.

- **TRIP DISTRIBUTION** **(06 Hours)**
  Interchange matrix Growth factor methods Synthetic Methods Calibration of Gravity model.

- **MODAL SPLIT** **(06 Hours)**
  Influential factors FHWA Procedure Diversion curves & surfaces- Discrete choice models, Concept, Types, BL, MNL & HL models.

- **TRIP ASSIGNMENT** **(06 Hours)**
  Trip Assignment Procedure Diversion curves- BPR model - All or Nothing assignment - Multipath assignment - Capacity restraint assignment User equilibrium and system equilibrium approach - Stochastic assignment approach.

- **LAND USE TRANSPORT SYSTEM** **(06 Hours)**
  Urban system components - Urban spatial structure Accessibility - Location theory - Land use models - Land use transport models, Lowry & Garin Lowry models.

- **URBAN PUBLIC TRANSPORTATION** **(06 Hours)**
  Urban growth and public transport needs - transit mode classifications - transit characteristics - fleet size and capacity estimation, goods/logistic transportation.

(Total Lectures: 45 hours)

13. Books Recommended

1. B G Hutchinson, Principles of Urban Transportation System Planning, Mc-Graw Hill, 1974
2. J D Ortuzar and L G Willumsen, Modeling Transport, John Wiley & Sons,4th Edition, 2011.
3. Khisty, C. Jotio, and B. Kent Lall. 2002. Transportation Engineering an Introduction.
4. P Chakroborty and N Das, Principles of Transportation Engineering, PHI, New Delhi, 2003.
5. P Sarkar, V Maitry and G J Joshi, Transportation Planning Principles, Practices & Policies, PHI, New Delhi, 2014.

14. Mapping of COs and POs

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

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

15. Mapping of COs and PSOs

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

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

	L	T	P	C
CE 343 HIGHWAY GEOMETRIC DESIGN	**3**	**0**	**0**	**3**

Pre-Requisite Courses: Nil

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

CO1: comprehend the basic principles of geometric design in the context of transportation engineering and planning.
CO2: apply design criteria for the geometric design of different roadway elements.
CO3: interpret user perception and its association with geometric design of different roadway elements.
CO4: evaluate the performance of highway alignment by assessing its geometry consistency
CO5: compile the engineering safety measures to improve the reliability in the geometric design.

- **Introduction (05 Hours)**

Traffic characteristics, topography and physical features; design controls; speed and safety; space standards for urban; rural and hill roads, access controls, location and spacing of access points

- **Human and Vehicle Factors (05 Hours)**

Perceptions and application of human factors in the design and representative vehicle factors used in geometric design, driver expectancy and errors, considerations of high-speed highway facilities

- **Cross-section Elements (05 Hours)**

Single lane, two lane, multi-lane highways, expressways and urban roads; street design concepts; bicycle tracks; pedestrian facilities; street furniture; design of speed breaker, road side clear zones

- **Highway Alignment (10 Hours)**

Horizontal alignment; curve design; super-elevation design; friction co-efficient;transition curve design; attainment of super-elevation; pavement widening; sight distance on horizontal curves; vertical alignment; gradients; grade compensation; design of vertical curves, 3D alignment and analysis; alignment coordination, vertical clearance for underpass and elevated structures, hill roads considerations, case studies

- **Intersection and Interchange Design (10 Hours)**

Design consideration and objectives, visibility requirements, principles of channelization, types of intersections and design, roundabouts, interchange design; on-ramps (flyovers and access-controlled facilities), acceleration and deceleration lanes, two-way turn lanes , case studies

- **Geometric design consistency (05 Hours)**

Evaluate inconsistency of geometric design; likelihood of the crashes; reliability-based design; engineering safety measures, traffic calming measures, case studies

- **Design of Facilities (05 Hours)**

Design of parking facilities (on-street, off-street, and multi-storeyed); design of bus shelters and bus lay-bye, bus terminal, truck terminals and truck lay-bye, container terminal, toll plaza, foot-over bridge and sky-walk, road side amenities, case studies

(Total Hours: 45)

REFERENCES:

1. Wright, P.H. &Dixon, K.K., "Highway Engineering," 7th Ed., John Wiley &Sons. (2014)
2. Transportation Research Board (TRB), Highways Capacity Manual, National Research Council, Washington D.C. (2010 edition)
3. Indo-HCM: Indian Highway Capacity Manual (Indo-HCM). CSIR-Central Road Research Institute (CRRI), New Delhi (2017)
4. Khisty, C.J. and Lal, B.K., "Transportation engineering – An Introduction," prentice Hall of India Pvt. Ltd. (2006)
5. Kadiyali, L.R., "Traffic Engineering and Transport Planning," Khanna Publishers. (2008)
6. A policy on geometric design of highways and streets, American Association of State Highway Officials, 2011.
7. Geometric design standards for urban roads in plains (IRC: 86-1983), The Indian Roads Congress, 1983. 3. Geometric design standards for rural (non-urban) highways (IRC: 73-1980), The Indian Roads Congress, 1980.
8. Guidelines for expressways – Part I, Ministry of Road Transport & Highways, 2010.
9. Roadside design guide, American Association of State Highway Officials, 2002.
10. Manual of geometric design standards for Canadian roads, Transportation Associations of Canada, 1986.
11. Pline, J.L., Traffic Engineering Handbook, Institute of Transportation Engineers, 2009.
12. Manual on Uniform Traffic Control Devices, Federal Highway Administration, 2009.

S.K. Khanna and C.E.G. Justo, Highway Engineering, Khanna Publishers, Roorkee, 2

Mapping of COs and POs

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

Mapping of COs and PSOs

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

Note: 1: Slightly 2: Moderately 3: Substantially

CE345: TOURISM PLANNING & DEVELOPMENT

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 tourism planning and development in urban and regional scale
CO2	Assess the impact of sustainable tourism development on natural environment
CO3	Promote tourism for economic development of a country.
CO4	Practice modern techniques of tourism planning and development.
CO5	Develop Revenue generation techniques through Tourism planning

2. Syllabus

- **INTRODUCTION TO TOURISM: (10 Hours)**

  Definitions, scope, nature, classification and dimension, tourism as an industry, tourism in developed and developing world. Tourism as system, Demand and supply, Relationship between Tourism and Urban Development. Creation of Urban Space for recreation and tourism, Principles of Recreation, Leisure and Tourism. Nature and scope of a tourism plan- key issues and stages, data requirements, surveys, role of key players / stake holders in tourism policy and planning.

- **SUSTAINABLE PLANNING FOR TOURISM DEVELOPMENT: (15 Hours)**

  Natural resource assessment; Techniques of tourism potential analysis; Concept of Eco-tourism, Environmental threats and planning precautions. Concepts and parametric analysis; Integrated wildlife, Tourism multiplier and forecasting Methods: capacity building and carrying capacity planning for tourism projects, tourism and cultural and social change: Socio, Tourism infrastructure development, Tourism Project conception and preparation for project report.

- **TOURISM MANAGEMENT AND ECONOMICS: (10 Hours)**

  Management and Economics of tourism industry and development management. Tourism marketing - concept, techniques and strategies. GIS application in tourism development, policies and programme at National State and District level. Tourism planning case studies.

- **POLICIES AND PROGRAMMES: (10 Hours)**

  Tourism policies at various levels. Case studies: Indian Site, 7 Projects for Gujarat Tourism.

(Total Lectures: 45 Hours)

3. Books Recommended

1. Hall, C. (2008). Tourism Planning: Policies, Process & relationship. Prentice Hall.
2. Gunn, C. (2009). Tourism Planning: Basics, Concepts, cases. France & Taylor Publication
3. Goeldner, C. and Ritchie J. (2009). Tourism: Principles, Practices, Philosophies. John Wiley & Sons
4. Planning Commission (2012). Working Group Report on Tourism (2012-2017). Govt. of India
5. Ministry of Tourism. (2011). Strategic Action Plan for Tourism in India. Govt. of India. Ministry of Tourism.

4. Mapping of COs and POs

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

CO4	2	2	2	2	3	1	1	1	3	2	2	1
CO5	1	1	1	1	2	2	2	2	2	2	1	1

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

5. Mapping of COs and PSOs

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

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

CE347 URBAN DESIGN & LANDSCAPE DEVELOPMENT

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 components of Urban Design.
CO2	Understand the concept of Landscape Planning in urban context.
CO3	Implement sustainable and balanced urban planning with beauty, convenience and health with the use of dynamic architectural techniques.
CO4	Design using strategies like concept planning, designing, development; zoning by function to balance urban area.
CO5	Develop Revenue generation techniques.

2. Syllabus

- **SCOPE AND OBJECTIVES OF URBAN DESIGN (04 Hours)**

  Its relationwith architecture and urban planning, scale of various urban design projects, regional and city level, urban design survey, inventories, techniques/approaches to urban design. Concepts and theories in landscape architecture/city planning urban design in the historical perspective, origin of forms, organization of space, relationship of activity with buildings.

- **BEHAVIORAL ISSUES IN URBAN DESIGN (04 Hours)**

  Principals of urban spatial organization, urban scale, urban spaces, urban massing, quality of urban enclosure. Imageability, townscape and elements of urban design (Gordon, Cullen, Kevin Lynch) Urban conservation with historic preservation and integrated approach to conservation, urban renewal, its purpose, economics and planning issues.

- **URBAN DESIGN AT MICRO LEVEL (06 Hours)**

  Campus planning, city centres, transportation corridors, residential neighbourhood, water fronts. Urban landscape in relation to topography.

- **DEVELOPMENT CONTROL GUIDELINES (06 Hours)**

  Zoning, Historical examples of urban design projects. Evaluation/ feasibility study of urban design projects.

- **OBJECTIVES AND SCOPE OF LANDSCAPE PLANNING (06 Hours)**

  Behavioural issues landscape design, principles and aesthetic theory in landscape design, Land from design and elements of geomorphology, hydrology, paedology, drainage in landscape planning. Spatial organization of selected cities, emphasizing landscape assessment.

  Siteand resources inventory Methods, analyses and appraisal, landscape suitability analysis, Plant characteristics and planting design, environmental factors in landscape planning.

- **OUTDOOR RECREATION AND TOURISM (02 Hours)**

  Planning and design issues.

- **LANDSCAPE PLANNING (08 Hours)**

  Urban and regional level open spaces, residential neighbourhoods, urban roads and regional highways, coastal area landscape planning. Landscape Urbanism, sustainable landscape, streetscape Waterfronts, evolution of different landscape philosophies.

- **OPEN SPACE SYSTEM (06 Hours)**

Concept for opens space and park system in urban area. Open space development in urban design context. Evolution of Public Park as a major component of urban landscape. Open space development in new towns. Park systems, water fronts. Green infrastructure. Urban ecology, urban water sheds.

- **EVALUATION PROCESS IN LANDSCAPE PLANNING (03 Hours)**

  Critical appraisal of historical examples of landscape plans. Relevance of Social forestry in urban and regional landscape planning.

(Total Lectures: 45 Hours)

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3. Books Recommended

1. Paul, Spreiregen D., "Urban Design: The Architecture of Town and Cities", New York: McGraw Hill Book Company,2020
2. Shimizu H. and Murayama A., "Clinical Environmental Approaches in Landscape Planning", Urban and Landscape Perspectives, 2014
3. John.F., "Urban Landscape Design",Teneues Media Gmbh& Co, 2008
4. Grazia.C, "Human Smart Cities: Rethinking the Interplay between Design and Planning", Springer, 2018
5. Nigel D. "The Dynamic Landscape: Design, Ecology and Management of Naturalistic Urban Planting", Taylor & Francis

6. Mapping of COs and POs

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

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

7. Mapping of COs and PSOs

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

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

CE349: PLANNING LEGISLATION

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	Describe different legislations related to urban planning and policy.
CO2	Demonstrate the legal procedures for preparation and implementation of Regional Plans, Master Plans and Town Planning Schemes.
CO3	Illustrate the regulations for planning.
CO4	Explain the role of politics in planning
CO5	Review of constitutional amendments and their relevance to planning and plan implementation

2. Syllabus

- **PLANNING LEGISLATION AND POLICY FORMULATION AND APPRAISAL: (12 Hours)**

  Evolution; An over view of legal tools connected with Urban Planning and Development, Town and Country Planning Act, Improvement Trust Act, Urban Planning and Development Authorities Act – objectives, contents, procedures for preparation and implementation of Regional Plans, Master Plans and Town Planning Schemes. Various Acts related to urban governance, planning and development organizations, land resources, environment protection, and public participation in statutory planning process; Approaches of formulation of policies, appraisal of policies.

- **UNDERSTANDING OF LAW: (08 Hours)**

  Concepts, sources, terminologies, significance of law and its relationship to Urban Planning benefits of statutory backing for schemes - eminent domain and police powers; Indian Constitution: concept and contents; 73rd and 74th Constitution Amendment Act, provision regarding property rights.

- **CITY AND THE STATE: (08 Hours)**

  State as a manager of resources – property rights, norms and standards – Government market and market by Government – Regulatory State, Reforming State, and Rent Seeking State – their spatial implications; Development planning and the Indian state – Centralization, powerlessness and decentralization; spatial politics and competition; Politics of the State and bureaucracy; New State spaces, invited and contested spaces – changing role of the state.

- **LEGISLATION FOR URBAN MANAGERS: (07 Hours)**

  Significance and Objectives of Legislation for Planners, Constitutional Basis and Provisions, Legal Framework in Town and Country Planning, Preparation and Implementation of Regional Plan/Development plan, T.P. Scheme in Light of The Gujarat Town Planning Act, 1976, Provisions of Land Acquisition Act, Urban Land Ceiling Act and Conservation Act.

- **REGULATIONS: (06 Hours)**

  Financing of infrastructure including exactions, tax policies, funding municipal services. Zoning and land use control regulatory takings, vested rights, permits and project review.

- **ROLES OF POLITICS IN PLANNING: (04 Hours)**

  Politics related to land, shelter, urban infrastructure, resources; Regeneration and redevelopment politics; politics of provision, financing and pricing; decision-making and decision-taking, Politics and emergence of civil society – NGO, CBO and their role in planning, development and management, collective bargaining and collective action.

(Total Lectures: 45 Hours)

3. Books Recommended

1. URDPFI Guidelines, Ministry of Housing and Urban Dev., Govt. Of India. 2015
2. The Gujarat Town Planning and Urban Development Act, 1976
3. Comprehensive General Development Control Regulations – 2017. Govt. of Gujarat
4. Handbook of Environmental Laws, Vol. I and II, Enviro-media Publication, Karad, Maharashtra.
5. Maharashtra Act No. IV of 1975: The Bombay Meetropolitan Region Development Authority Act, 1974, Govt. of Maharashtra, Law and Judiciary Deptt., published by the Director General, Govt. Printing, Stationery and Publications, Maharashtra State, Bombay 400004

8. Mapping of COs and POs

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

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

9. Mapping of COs and PSOs

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

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

CE 351 Advanced Geomatics Surveying

L	T	P	Credit
3	1	0	04

1. Course Outcomes (COs)

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

CO1	Explain the concept of EDM and Total Station Survey
CO2	Analyze computation and measurement of relief displacement, development of mosaic etc. using principle of photogrammetry
CO3	Compute and detail Azimuth, Declination etc. of celestial bodies using principle of astronomy.
CO4	Brief the concept of Geospatial Technologies
CO5	Explain advanced surveying techniques of Terrain Data Collection including ALTM, LIDAR, UAV, DEM

2. Syllabus

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

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 (08 Hours)

Introduction, purposes, astronomical terms, Celestial Co-ordinate Systems

Concepts of Geospatial Technologies (08 Hours)

Introduction to Geospatial Technologies, Fundamental of Remote Sensing, Overview of GIS, Fundamentals of GPS, Applications of Geomatics Engineering tools in various engineering projects, Basics of Geospatial Softwares

Terrain Data Collection (09 Hours)

ALTM (Airborne laser thematic mapper) Concept

LiDAR (Light Detection and Ranging) - Basic principles, terrestrial and airborne LiDAR, data collection techniques, point cloud generation, analysis of data, 3D mapping.

UAV (Unmanned Aerial Vehicle) (Drone): Introduction, components, data collection, data types, data analysis software, applications in civil engineering

Profiles, Digital Elevation Models

(Total Lecture Hours: 45)

4. 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. Lille sand 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 Aron off, “Geographic Information Systems: A management perspective”, WDL Publications, Canada, (1989)

5. Mapping of COs and POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	2	3	2	3	1	1	2	1	1	2
CO-2	1	2	2	2	3	3	3	1	1	2	3	2
CO-3	2	2	2	2	1	1	3	3	3	3	3	1
CO-4	2	3	3	3	3	3	1	1	1	1	1	2
CO-5	3	2	3	2	3	1	1	1	2	3	3	2

6. Mapping of COs and PSOs

	PSO-1	PSO-2	PSO-3
CO-1	1	2	3
CO-2	2	2	3
CO-3	1	1	2
CO-4	2	1	2
CO-5	1	3	2

1. Demonstration of total station and its uses
2. Comparison between aerial photographs and map.
3. Demonstration of GPS and its uses
4. Demonstration on GIS software
5. Demonstration on Remote Sensing software

CE 353 Stochastic Hydrology

L	T	P	C
3	1	0	4

16. Course Outcomes (COs)

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

CO1	Apply knowledge of stochastic hydrology.
CO2	Appraise basic concepts of probability theory
CO3	Elaborate various types of time series analyses
CO4	Explain various types of stochastic models
CO5	Fit probability distribution to hydrologic data

17. Syllabus

- **INTRODUCTION (02Hours)**
  Stochastic hydrology – Applications of stochastic hydrology.

- **FUNDAMENTALS OF STATISTICS (10 Hours)**
  Concept of probability – Discrete and continuous variables – Probability distributions including fitting to hydrological data.

- **TIME SERIES ANALYSIS (08 Hours)**
  Definitions and classification of time series – Stochastic processes – Components of time series – Trend analysis – Periodicity – Auto-correlation and spectral analysis – Frequency analysis.

- **STOCHASTIC MODELS (13 Hours)**
  Univariate models: classification of models – univariate annual models with normal and other distributions – univariate annual models obeying Hurst's law – univariate seasonal models. Multivariate models: multisite annual models – multisite AR models for seasonal flows – MA models – ARIMA models – non-stationary processes.

- **CASE STUDIES (12 Hours)**
  Examples related to fitting probability distributions – Trend analysis – Spectral analysis – Stochastic models in hydrologic forecasting.

[Total Lectures: 45 hours]

3. Books Recommended

1. N T Kottegoda, Stochastic Water Resources Technology, The Macmillan Press Ltd., 1980.
2. V P Singh, Handbook of Applied Hydrology, Second Edition, McGraw-Hill, New York, 2016.
3. V Yevjevich, Stochastic Processes in Hydrology, Water Resources Publications, Fort Collins, Colorado, 1972.
4. C T Hann, Statistical Methods in Hydrology, Wiley–Blackwell, 2002 (Second Edition).
5. R T Clarke, Mathematical Models in Hydrology, FAO, 1973.

4. Mapping of COs and POs

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

1-Low 2-Moderate 3-High

CE 355

ADVANCED HYDROLOGIC ANALYSIS AND DESIGN

L	T	P	Credit
3	1	0	4

1. Course Outcomes (COs)

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

CO1	Synthesize the solution including precipitation, evapo-transpiration and infiltration processes
CO2	Estimate flood hydrographs for gauged and ungauged catchments
CO3	Apply flood routing models to rivers and reservoirs
CO4	Compute IDF curves and floods of different return periods
CO5	Design of Storm Drainage network

2. Syllabus

PRECIPITATION AND EVAPOTRANSPIRATION (12 Hours)

Global hydrological cycle, Atmospheric water, water vapour, Greenhouse effect, Computation and measurement of precipitation, missing data analysis and check on consistency of data, trend analysis, evaporation, evapo-transpiration, spatio-temporal distribution of rainfall.

FLOW THROUGH UNSATURATED ZONE (08 Hours)

Unsaturated flow models for potential infiltration rate - Horton's equation, Philips equation and Green-Ampt model, Models for actual infiltration rate, Computation of excess rainfall hyetograph from observed flood hydrograph using ϕ-index, and SCS (NRCS) curve number method.

FLOOD ESTIMATION METHODS- DETERMINISTIC APPROACHES (10 Hours)

Unit hydrograph theory, derivation of instantaneous unit hydrograph and synthetic unit hydrograph. Rational method, Project hydrology Design flood PMF storm transportation, PMP and PMF for project by using conceptual models, Introduction to glacier lake outburst flood (GLOF).

FLOOD ROUTING (07 Hours)

Lumped flow routing, distributed flow routing models including kinematic, diffusion and dynamic wave routing models. Numerical solutions of distributed flow routing models.

HYDROLOGIC STATISTICS (08 Hours)

Hydrologic statistics, Flood forecasting and flood frequency analysis. Hydrologic design of storm water drainage system, preparation

[Total Hours: 45 Hours, Tutorial: 15 hours]

3. References

1. Chow, V. T., Maidment, D. R., and Mays, L. W., "Applied Hydrology", McGraw Hill International editions, New Delhi, 2017.

2. Subramanya, K., “Engineering Hydrology”, Fourth Edition, Tata McGraw-Hill Publishing company Ltd., New Delhi, 2017.
3. Singh, V. P., “Elementary Hydrology”, Prentice Hall, New Delhi,1991.
4. Ojha, C. S. P., Bhunya, P., and Berndtsson, P., “Engineering Hydrology”, Oxford University Press, Noida, 2008.
5. Raghunath, H. M., “Hydrology Principles, Analysis and Design”, New Age International Pvt. Ltd., New Delhi, 2015.

4. Mapping of COs and POs

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

1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

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

1-Low 2-Moderate 3-High

L	T	P	Credit
3	1	0	4

CE 357

Water Supply Distribution Systems

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1. Course Outcomes (COs)

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

CO1	Identify different intake structures and water treatment processes
CO2	Understand parameters involved in design of water distribution system
CO3	Design water distribution system
CO4	Optimize water distribution system.
CO5	Analyse surge in the pressurized water supply network.

2. Syllabus

INTRODUCTION (04 Hours)
Introduction to Intake structure, Water Quality, Hydraulics of water treatment processes.

TYPE OF DISTRIBUTION SYSTEMS (08 Hours)
Equivalent pipe, parameters in distribution system analysis, parameters interrelationship, Formulation of equation, Gravity and Rising Main, Location and Design Principles.

ANALYSIS OF WATER DISTRIBUTION SYSTEM (10 Hours)
Methods of analysis: (i) Hardy-Cross Method (ii) Newton-Raphson method and (iii) Linear Theory Method (iv) Gradient Method.

DESIGN AND OPTIMIZATION OF WATER DISTRIBUTION SYSTEM (13 Hours)
Design: Trial and error method of design, cost-head loss ratio method. Optimization using linear programming techniques, Surge analysis in water distribution systems, Pump duty stations and detailing valves, Pressure transients in pipe flow.

CASE STUDIES (10 Hours)
Case studies on new Water Distribution Systems, Rehabilitation systems, DPR preparation of a water supply system including operation and maintenance through SCADA.

[Total Hours: 45 Hours, Tutorial: 15 hours]

3. References:

1. Bhave, P. R., “Optimal Design of Water Distribution Networks”, Narosa Publishing House, New Delhi, 2003.
2. Streeter, V. L. and Wylie, E. D., “Fluid Transients in Systems”, Pearson., 2010.
3. Bhave, P. R., and Gupta, R., “Analysis of Water Distribution Networks”, Narosa Publishing House, New Delhi and Alpha-Science Publication, UK, 2006.
4. CPHEEO (1999), Manual on Water Supply and Treatment, Central Public Health and Environmental Engineering Organisation, Ministry Housing and Urban Affairs (Previously known as Ministry of Urban Development, New Delhi, Third Edition.
5. IS 10500:2012, Drinking Water-Specification, Second Revision, 2012.

4. Mapping of COs and POs

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

1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

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

1-Low 2-Moderate 3-High

GLOBAL ELECTIVE / ELECTIVE 4

CE 359 Industrial Safety and Environment

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 safety management n construction.
CO2	Apply knowledge of accident theories to prevent accidents.
CO3	Analyze technologies for construction safety.
CO4	Assess standards and acts for construction safety.
CO5	Design and audit for safety management system.

2. Syllabus

- **OVERVIEW OF CONSTRUCTION SAFETY MANAGEMENT (06 Hours)**
  Terminologies related to safety management, safety management systems, safety climate, safety organization structure, safety culture, safety performance, roles and responsibilities of various persons for managing safety in construction, project management techniques for safety management in construction.

- **PREVENTION OF ACCIDENTS (09 Hours)**
  Accident and incident cause theories, causes of major injuries, cost of accident, safety during construction, accidents of different stages of construction, accidents during receiving, unloading, shifting and storage, safety guidelines for storage, safety facilities at sites, coordination interface between civil and erection works, hazardous material and atmosphere.

- **SAFETY TECHNOLOGIES (09 Hours)**
  Personal protective equipment, emergency rescue equipment, safety aids, first aid health care, site hoardings, safety training on site, prevention and protection equipment for working on heights, modern scaffolding technology, advance technologies and computer applications in safety management.

- **SAFETY TRAINING AND EDUCATION (06 Hours)**
  Introduction to safety training and education, need of safety training and education, importance of training and education, requirements of safety training and education, frequency of safety training, safety audit and inspection education, training of rules and acts of safety management, safety reporting training.

- **STANDARDS AND ACTS FOR CONSTRUCTION SAFETY (09 Hours)**
  Construction safety related acts and rules (central act, central and state rules), building and other construction workers (BOCW) act and central rules, the explosives act and rules, the motor vehicle act and rules, the public liability insurance act and rules, the water (prevention and control of pollution) act and rules, the air (prevention and control of pollution) act and rules, battery management and handling rules, gas cylinder rules, hazardous wastes (management and handling) rules, contract labour (Regulation and Abolition) act and rules, workman compensation acts.

- **SAFETY MANAGEMENT SYSTEM (06 Hours)**
  Policy regarding safety in organization, safety organization and persons, policy documentations, safety budget, investment in safety, training and education systems and schedules, induction programs, safety plan, investigation and analysis of incident, analysis of safety data.

(Total Lectures: 45 hours)

3. Books Recommended

1. K N Jha, D A Patel and A Singh, Construction Safety Management, Pearson, Noida, 2022.
2. S Rowlinson, Construction Safety Management Systems, Routledge, London, 2004.
3. H Lingard and S M Rowlinson, Occupational Health and Safety in Construction Project Management, Routledge, Oxford, 2004.
4. C D Reese and J V Eidson, Handbook of OSHA Construction Safety and Health, CRC Press, New York, 2006.
5. A Griffith and T Howarth, Construction Health and Safety Management, Routledge, London, 2014.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 361 Ground Engineering

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	Illustrate the methods of Geotechnical field investigations and interpretations
CO2	Identify the expansive soils and collapsible soils and provide solutions to rest foundations on same soil
CO3	Evaluate the soil dynamic properties and analyze the parameters for design of machine foundations
CO4	Provide solutions for treatment of weak deposits, such as soft clay, loose sand, etc, Types of dynamic load, Earthquake load.
CO5	Interpret the waves in layered media and evaluate the liquefaction susceptibility from laboratory and field-testing results

2. Syllabus

- **EXPLORATION TECHNIQUES** **(07 Hours)**
  Objectives, Methods, Suitability, Sub soil investigation, Bore log, Penetration tests, Geophysical methods, Report preparation

- **FOUNDATION ON EXPANSIVE SOIL** **(07 Hours)**
  Properties, Problems, Identification, Classification, Remedial measures, Case studies

- **FOUNDATION ON COLLAPSIBLE SOIL** **(07 Hours)**
  Definition, Types of collapsible soil, Physical parameters for identification, Procedure for calculating collapse settlement, Case histories of stabilization of collapsible soil

- **FOUNDATIONS FOR MACHINES** **(08 Hours)**
  Classification, General requirements, Dynamic parameters of Soil, Foundations for reciprocating and impact type machines, Vibration isolation

- **PRELOADING AND SAND DRAIN** **(08 Hours)**
  Precompression, General considerations, Sand drains and its application, Prefabricated vertical drains

- **EARTHQUAKE GEOTECHNIQUES** **(08 Hours)**
  Types, Seismic waves, Location of earthquake, Factors influencing ground motion, Liquefaction evaluation of liquefaction susceptibility.

(Total Lectures: 45 hours)

3. Books Recommended

1. B M Das, Principles of Foundation Engineering, Cengage Learning, New Delhi, 2015.
2. S L Kramer, Geotechnical Earthquake Engineering, Pearson Education India, new Delhi, 1996.
3. S K Gulhati, M Datta, Geotechnical Engineering, Tata Mc Graw Hill Publishing Company Limited, New Delhi, 2005.

4. R W Day, Geotechnical Engineer's Portable Handbook, Columbus: McGraw Hill, 2000.
5. M R Hausmann, Engineering Principles of Ground Modification, McGraw Hill Publishing Company, New York, 1990.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 363 Introduction to Wind Engineering

L	T	P	C
3	1	0	4

18. Course Outcomes (COs)

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

CO1	Illustrate different characteristics of wind.
CO2	Determine dynamic effects of wind load on structures.
CO3	Describe about wind tunnels and various available wind flow measuring techniques.
CO4	Design a structure for different types of wind induced loadings.
CO5	Estimate wind induced load according to IS – 875 (Part III)

19. Syllabus

- **WIND CHARACTERISTICS (11 Hours)**
  Variation of wind velocity - atmospheric circulations - pressure gradient force, coriolis force, frictionless wind balance, geo strophic flow, boundary layer - Extra ordinary winds: Foehn, Bora, Cyclones, Tornadoes, etc.

- **STATIC AND DYNAMIC WIND EFFECTS (17 Hours)**
  Wind induced vibrations - flow around bluff bodies - along wind and across wind response – flutter - galloping - vortex shedding - locking - ovalling - analysis of dynamic wind loads - codal provisions - gust factor, dynamic response factor - wind load calculations as per IS 875 (part III) - vibration control and structural monitoring - exposure to perturbation method, averaging techniques.

- **WIND TUNNEL TESTING (11 Hours)**
  Open circuit and closed circuit wind tunnels - rigid and aero elastic models - wind tunnel measurements and instruments along with site visit.

- **CASE STUDIES (06 Hours)**
  Low rise buildings - parking sheds - workshop building - multi-storey building - water tanks - towers - chimneys - bridges.

(Total Lectures: 45 hours)

20. Tutorials

The students will be required to solve at least five examples and related theories from each topic as part of their assignment or tutorial. This helps students gain experience in implementing wind analyses to design various real-life problems applied in the field of structural engineering.

(Total Tutorials: 15 hours)

21. Books Recommended

6. Balendra, T. Vibration of buildings to wind and earthquake loads. Springer Science & Business Media, 2012.
7. Holmes, J. D., Paton, C., & Kerwin, R. Wind loading of structures. CRC press, 2007.
8. Sachs, P. Wind forces in engineering. Elsevier, 2013.
9. Simiu, E., & Yeo, D. Wind effects on structures: Modern structural design for wind. John Wiley & Sons, New York, 2019.
10. Taher, R. Building Design for Wind Forces, McGraw-Hill Education, New York, 2019.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

	L	T	P	C
CE 365 TRANSPORTATION SAFETY & ENVIRONMENT	**3**	**0**	**0**	**3**

Pre Requisite Courses: Traffic Engineering & Management

Course Outcomes (COs)

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

CO1	Analyse the present scenario about transport safety and environment with a multidisciplinary approach.
CO2	Examine factors affecting road safety engineering and crash investigation, human factors relating to crashes/accidents, crash/accident.
CO3	Predict hazard identification related to the transport safety and environment and take management measures for improving safety and environment.
CO4	Create awareness about empathetic and improving the present practices related to the Transportation Safety Audit and Environmental Impact Assessment (EIA) for transportation projects.
CO5	Evaluate effectiveness of measures for improving traffic safety and environment.

- **INTRODUCTION (06 Hours)**

  Transportation Safety scenario in India and World, Accident Characteristics, Distribution among different modes. Need of Planning for Network, Land Use and Road Environment for Safety, Designing for Safety: Road Link Design, Junctions. Introduction to Road Safety Engineering and Crash Investigation, Human Factors Relating to Crashes/Accidents, Crash/Accident

- **ROAD SAFETY DIAGNOSIS (06 Hours)**

  Investigation & Crash Problem Diagnosing, Crash Problems into Solutions & Crash, Investigation Reporting, Crash/Accident, Costing, Economic Appraisal. Safety at Construction Site: Safety provisions for workers at construction site, Construction Zone markings, signs.

- **ROAD SAFETY AUDIT (10 Hours)**

  Road Safety Auditing: An Introduction, Concept and need of Road Safety Audit (RSA). Procedures in RSA, design standards, audit tasks, stages of road safety audit, Road Safety Audit Types, key legal aspects, process, audit team and requirements, Checklist, how to use Checklists Road Safety inspection.

- **TRANSPORT AND ENVIRONMENT ISSUES (08 Hours)**

  Introduction to transport and the environment: Context, mechanisms and sustainability; Air Pollution: Mechanisms, technology solutions, modelling and social costs; Traffic Noise: Units, sources, and impacts Climate Change: Transport contribution, potential impacts, regulatory framework and policies.

- **MEASUREMENT AND MODELLING (08 Hours)**

  Environmental planning and assessment practices, Measurement of environmental impacts of transport: Emissions, air quality and noise, Modelling of environmental impacts of transport: Emissions, air quality and noise, Land use transport relationships.

- **IMPACT ASSESSMENT (07 Hours)**

  Environmental Impact Assessment for Transportation Projects: Basic Concepts, Objectives, Transportation Related Environmental Impacts; Vehicular Impacts; Safety & Capacity Impacts; Roadway Impacts, Construction Impacts, Environmental Impact Assessment, Environmental Impact Statement, Environment Audit, Typical case studies.

(Total Lectures: 45hours)

Mapping of COs and POs

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

Mapping of COs and PSOs

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

Note: 1: Slightly 2: Moderately 3: Substantially

Books Recommended

1. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997 (reprinted 2002).
2. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.
3. J. Stannard Baker, Traffic Collision Investigation, Northwestern University Center for Public Safety, 2002.
4. Leonard Evans, Traffic Safety, Science Serving Society, 2004.
5. Lynn B. Fricke, Traffic Accident Reconstruction, Northwestern University Center for Public Safety, 1990.
6. Ogden, K.W. Safer Roads: A Guide to Road Safety Engineering. Avebury Technical, 1996.

7. Popkess C.A, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997
8. Rune Elvik and Truls Vaa, The Handbook of Road Safety Measures, Elsevier, 2004.
9. Towards Safe Roads in Developing country, TRL – ODA, 2004.
10. Geetam Tiwari and Dinesh Mohan, Transport Planning and Traffic Safety: Making Cities, Roads, and Vehicles Safer, CRC Press, 2016.
11. IRC SP:88 (2019) Manual on Road Safety Audit
12. Periodic NHAI Circulars.

CE 367 Hydropower Engineering

L	T	P	Credit
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Identify Issues related to hydropower development in India.
CO2	Assess hydropower potential of river basins.
CO3	Evaluate efficacy of hydropower plants.
CO4	Design intake structures and water conveyance system.
CO5	Able to carry out power house planning.

2. Syllabus

Introduction **(02 hours)**
Energy sources for power generation, Power scenarios, Demand and supply of power, need of hydropower, General Hydrology, Environment and Hydro Power Development.

Planning for water power development **(04 hours)**
Introduction, Objectives of planning, planning for water power development, Estimation of available water, Power duration curve, Storage and pondage, Load studies, Technical terms related to hydropower, System integrated operational studies, Load prediction, Installed capacity, Size and number of units.

Topographical Survey and Geological/Geotechnical Investigation **(04 hours)**
Geological investigations studies for water power development, Geo technical investigations studies for water power development.

Power potential studies **(06 hours)**
Economics of Hydropower development, Economic value of hydropower, Cost of water power, Total annual cost of a hydro project (hydro power tariff), Operation and maintenance of hydro plants, hydro power markets.

Water Conveyance System **(08 hours)**
Intakes: Types, Location and Alignment of intakes, Losses in Intakes, Air- Entrainment at Intakes, Inlet aeration, Trash racks, Penstocks and Pressure Shafts, Surge shafts Hydrauli Valves and Gates

Classification and types of hydropower plants **(10 hours)**
Classifications, types, Storage power development, components of storage power development, economic aspects, social and rehabilitation aspects, Run-Off-River power Development, types of ROR, components of run-off-river power development, Run-of-power development on canal falls, Underground and pumped storage power plants, advantages, types and location of underground power station, its components, types of layout, limitations of underground power plants. Essential requirements of pumped storage power plant (PSPP), economics of PSPP, Cost of power generation.

Power House Planning **(07 hours)**
General layout of the power house and arrangement of hydropower units, Number and sizes f units, space allocation and dimensions, Super structure, Indoor, Semi-outdoor and Outdoor powerhouse, Lighting and Ventilation, Variation in design of power house, Safety requirements, Operation and maintenance of hydro plants.

Small Hydro Power Development **(04 hours)**

Introduction, Advantages of small hydropower, Classification of small hydropower, Components of small hydropower development, Choice of units, Economics of small hydropower schemes.

[Total Hours: 45 Hours]

3. References:

1. Dandekar, M. M., and Sharma, K. N., "Water Power Engineering", Vikas Publishing House, New Delhi,2013 (Second edition).
2. Deshmukh, M.M., "Water Power Engineering, Dhanpat Rai Publications", New Delhi, 1998.
3. Nigam, N. C., "Handbook of Hydropower Engineering", Nem Chand and Sons, Roorkee, 1999.
4. Sharma, R. K. and Sharma, T. K., "Water Power Engineering", S.Chand & Company, New Delhi, 2003.
5. Varshney, R.S., "Hydropower Structures", Nem Chand and Bros., Roorkee (U.P.), 2014.

5. Mapping of COs and POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	2	1	1	1	1	1	1	1	1	1	1
CO-2	1	2	1	1	1	1	1	1	1	1	1	1
CO-3	1	1	2	1	1	1	1	1	1	1	1	1
CO-4	1	1	2	2	2	1	1	1	1	1	1	1
CO-5	1	2	2	2	2	1	1	1	1	1	1	1

6. Mapping of COs and PSOs

	PSO-1	PSO-2	PSO-3
CO-1	1	1	1
CO-2	1	1	2
CO-3	2	2	1
CO-4	2	2	1
CO-5	2	1	1

6th Semester Core Subjects

CE 302 Estimation and Cost Analysis

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	Explain significance of estimation and specification.
CO2	Interpret BIS code of measurement cost indices.
CO3	Analyse cost estimation of civil structures.
CO4	Prepare rate analysis, specification and abstract of building items.
CO5	Explain the government procedure for SOR and BOQ

2. Syllabus

- **GENERAL: (02 Hours)**
  Significance of estimation and specification, role of civil surveyors, types of estimates, working drawing details, BS codes for measurements, Cost Indices.

- **QUANTITY ANALYSIS OF BUILIDNGS: (15 Hours)**
  Definition, Units of measurements, types of estimates, Different methods to find the quantities of civil works, Estimated cost and its importance, Provisions of IS-1200, for working out quantities and deductions in civil works, Entering the measurements in quantity sheet and calculation of quantities of various items of civil works, Estimation of earthwork and masonry, flooring, walls, openings, RCC components, staircase, timber (door and window) and steel work, load bearing and framed structures, Application using software

- **QUANTITY ANALYSIS OF SPECIAL STRUCTURES: (10 Hours)**
  Estimation of roads and CD works, earthen dams, irrigation channels, urban services estimation, electrical fixtures, approximate estimation of infrastructural elements.

- **BRIEF SPECIFICATIONS: (05 Hours)**
  Definition, Basic principles and purpose, Objectives and importance of specification, Types of specification, Care to be taken while drafting specifications, Drafting general specifications, and detailed specifications for various civil work items- Specification of materials and works.

- **RATE ANALYSIS & COST: (10 Hours)**
  Definition of rate analysis, Factors affecting rate analysis, overhead expenses, procedure for rate analysis, schedule of rates, Definition of task, Determination of man power and material requirement for a given quantity of items of civil works, study of present wages of labour and prices of traditional and modular materials in the market. Study of market rents of different construction tools plant and equipment, output of work force, Application using software

- **ABSTRACTING: (03 Hours)**
  Purpose of abstract, preparation of abstract, measurement and billing, Checking of bills and final bill, BS methods of abstracts, abstract statements, cost analysis, SOR and BOQ

(Total Lectures: 45 hours, Tutorials: 14 hours)

3. Practicals

1. Conduct Market survey of building materials
2. Estimation of building units
3. Estimation of road and C.D. works
4. Estimation of earthen dam and irrigation channel
5. Estimation of steel roof truss.
6. Estimation of plumbing and electrical services.
7. Drafting of specifications.
8. Rate analysis.

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10. Books Recommended

1. A Aggarwal and A K Upadhyay, Civil Estimating, Costing and Valuation, Kataria and Sons, New Delhi, 2013.
2. B N Dutta, Estimating and Costing, S. Dutta and Co., Lucknow, 2021.
3. G S Birdie, Estimating and Costing, Dhanpat Rai and Sons, Delhi, 2014.
4. P L Basin, Quantity Surveying, S. Chand and Co., New Delhi, 1990.
5. S C Rangwala, Elements of Estimating and Costing, Charotar Publishing Pvt Ltd., Anand, 2023.

11. Mapping of COs and POs

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

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

12. Mapping of COs and PSOs

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

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

CE 304 Water Resources Engineering

L	T	P	C
3	1	2	5

22. Course Outcomes (COs)

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

CO1	Estimate precipitation and abstractions.
CO2	Compute runoff and hydrographs and groundwater flow.
CO3	Analyze irrigation water requirements.
CO4	Explain important hydraulic structures.
CO5	Explain the aspects of water logging and drainage.

23. Syllabus

- **INTRODUCTION TO WATER RESOURCES ENGINEERING (02 Hours)**

  Introduction, importance of water resources engineering, need of water resources projects

- **PRECIPITATION AND ABSTRACTIONS (10 Hours)**

  Mechanism of precipitation, types and forms of precipitation, measurement techniques, rain gauge network, variability in precipitation, estimation of missing data, test for consistency of rainfall record, rainfall hyetograph, rainfall mass curve, areal average rainfall, intensity duration curves, evaporation, factors affecting evaporation, estimation of evaporation, evapotranspiration, measurement of evapotranspiration, initial loss, infiltration and infiltration indices.

- **RUN-OFF AND HYDROGRAPH (08 Hours)**

  Direct runoff and base flow; run off characteristics of streams, computation of runoff, rainfall runoff relationships, components of hydrograph and factors affecting shape of hydrograph, base flow separation, effective rainfall hyetograph, unit hydrograph theory, derivation of unit hydrograph of different duration

- **GROUND WATER HYDROLOGY (08 Hours)**

  Occurrence, distribution of ground water, specific yield of aquifers, flow of groundwater, Darcy's law, permeability, safe yield of a basin, compressibility of aquifer, storage coefficient, specific storage, hydraulics of wells under steady and introduction to unsteady condition in confined and unconfined aquifers, yield of wells, pumping and recuperation tests, types of tube wells.

- **WATER REQUIREMENTS OF CROPS (06 Hours)**

Classes and availability of soil water, available moisture depth, frequency of irrigation, relationship between duty, delta and base period, factors affecting duty, methods of improving duty, irrigation efficiencies, command areas, kharif, rabi and perennial crops, crop rotation, irrigation water requirement, design discharge of canal and storage capacity of reservoir based on irrigation requirement, types and methods of irrigation

- **HYDRAULIC STRUCTURES (08 Hours)**

Introduction to various hydraulic structures including necessity, location, types of dams, investigations for reservoir planning, site selection, storage zones, yield, spillways, energy dissipation structures, canal falls, cross regulators, head regulators, canal escapes, canal outlets, cross drainage works. Important aspects of design of hydraulic structures.

- **WATER LOGGING AND DRAINAGE (03 Hours)**

Definition, effects, causes and remedial measures of water logging, types of land drains, layout and spacing of tile drains, Leaching and salinity control.

[Total Lecturers: 45 hours, Tutorials: 15 hours]

24.Practical

1. Study of recording and non-recording rain gauges.
2. Study of pan evaporimeter.
3. Study of Infiltrometer.
4. Study of rainfall runoff relationship for given duration of storm.
5. Preparation of runoff hydrograph using rainfall simulator.
6. Study of rate of ground water recharge.
7. Study of Hele-Shaw apparatus.
8. Computation of water requirement of crops.
9. Computation of the reservoir capacity.
10. Study of sea water intrusion and associated problems.

25.Books Recommended

1. V P Singh, Elementary Hydrology, Prentice Hall, Englewood Cliffs, 1992.
2. K Subramanya, Engineering Hydrology, Tata Mc-Graw-Hill, New Delhi, 2013.
3. S K Garg, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, New Delhi, 2011.
4. B C Punmia, Irrigation and Water Power Engineering, Laxmi Publications, New Delhi, 2016.
5. G L Asawa, Irrigation and Water Resources Engineering, New Age International, New Delhi, 2014.

5. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	2	1	1	3	1	1	1	1	3	1	1
CO2	3	1	1	1	3	1	1	1	3	2	1	1
CO3	2	1	2	3	1	2	2	2	2	1	1	1
CO4	1	1	3	2	1	1	1	1	1	3	2	2
CO5	3	3	3	1	2	3	3	3	1	1	3	3

1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

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

1-Low 2-Moderate 3-High

CE 306 Design of Concrete Structures

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 the fundamental concept of limit state method for the design of concrete structural elements.
CO2	Use IS:456-2000 code of practice for the limit state design of concrete structural elements.
CO3	Design RC beams, slabs, columns.
CO4	Design of RC footings and Staircase.
CO5	Analyse earthquake resistant RC building frame.

2. Syllabus

- **INTRODUCTION (05 Hours)**
  Materials for reinforced cement concrete (RCC) – Design loads – Concrete structural systems – Basis of structural design – Principles of limit state design – Characteristics strength and design strength – idealized stress – Strain curve for materials – Design codes.

- **LIMIT STATE DESIGN OF BEAMS UNDER FLEXURE AND SHEAR (12 Hours)**
  Limit state of Collapse in Flexure – Design parameters of stress block – Analysis of singly reinforced rectangular sections – Moment of resistance – Design of singly and doubly reinforced rectangular section – Analysis and design of flanged beam sections. Behaviour of RC Beams under shear –Design shear reinforcement.

- **LIMIT STATE DESIGN OF SLABS (06 Hours)**
  Types of slabs – Behaviour of one way and two-way slabs – Design of one way simply supported and continuous slabs – Design of two-way slabs.

- **LIMIT STATE DESIGN OF COLUMNS (06 Hours)**
  Types of columns – Behaviour of axially loaded RC Columns-Uniaxial and Biaxial loaded column – Practical provision on Reinforcement Detailing.

- **LIMIT STATE DESIGN OF FOOTING (06 Hours)**
  Types of footings – General design consideration for RC Footings – Structural design of axially loaded isolated rectangular and circular footings – Analysis of footing subjected to vertical load and moments.

- **LIMIT STATE DESIGN OF RC STAIRCASE (04 Hours)**
  Types of staircases – Effective Span of staircases – Design of Dog-Legged staircase.

- **INTRODUCTION TO EARTHQUAKE RESISTANCE DESIGN (06 Hours)**
  Principles for consideration of design earthquake forces – Ductility requirement and detailing – Lateral force analysis of building systems – Analysis of RC building under earthquake forces.

(Total Lectures: 45 hours)

3. Tutorial

1. Design of Singly / Doubly RC rectangular, T, L beams.
2. Design of one way and two-way RC slabs.
3. Design of Axially Loaded, UniAxially loaded and BiAxially Loaded RC columns
4. Design of RC footings
5. Design of RC Staircase.

(Total: 15 hours)

4. Practical

1. Developing spreadsheet for the design of RC elements
2. Analysis and Design of RC building structure under lateral loading using software and prepare structural elements detailing drawing.

(Total: 30 hours)

5. Books Recommended

1. S U Pillai and D Menon, Reinforced Concrete Design, 4th edition, Tata Mc Graw Hill Publication Ltd, New Delhi. 2022.
2. H J Shah, Reinforced Concrete, Vol-1: Part-I and II, 12th edition, Charotar Publishing House, Anand, 2021.
3. M L Gambhir, Design of Reinforced Concrete, Prentice Hall of India, New Delhi, 2023.
4. P C Varghese, Limit State Design of Reinforced Concrete, 2nd edition, PHI Learning Private Limited, 2022.
5. N Krishna Raju, Design of Reinforced Concrete Structures: IS 456-2000, 4th edition, CBS Publication, 2019.

6. Mapping of COs and Pos

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

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

7. Mapping of COs and PSOs

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

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

Core Elective/Elective 5

6^{th} Semester, 3^{rd} Year UG

CE 332 Professional Practice

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 the organizational setup and procedures in construction firms.
CO2	Analyze the tendering process and contract management principles.
CO3	Manage construction claims and apply alternative dispute resolution techniques.
CO4	Apply methods of valuation in real estate and construction projects.
CO5	Understand entrepreneurship development and intellectual property rights

2. Syllabus

- **INTRODUCTION TO PROFESSION (08 Hours)**
  Organisational set up, working of professional firms, office procedures, construction contracts, legal aspects, professional charges, the role of stakeholders, classification of contractors and projects, execution of work, book keeping, measurement book, store procedure, mode of payments, insurance.

- **TENDERING AND CONTRACTING (10 Hours)**
  Tender and tendering process, types of tenders and contracts, contract document, condition of contract, Indian contract act, improper work and defect liability period, liquidated damages, price escalation, contract breach, certificates and payments, duties and liabilities, sub contract, Introduction to The Indian Contract Act, 1872.

- **CLAIMS AND ALTERNATIVE DISPUTE RESOLUTION TECHNIQUES (09 Hours)**
  Sources of claims, claim management, causes of disputes, delay, negotiation, meditation, the Arbitration and Conciliation Act 1996, the purpose of arbitration, the powers and duties of arbitrator, arbitration and building contract. Types of arbitration, easement characteristics types, Introduction to FIDIC contract.

- **VALUATION (12 Hours)**
  Definition, market value, freehold and leasehold, sinking fund, depreciation methods of valuation, a rental method of valuation, land and building based development method of valuation, examples.

- **ENTREPRENEURSHIP DEVELOPMENT (03 Hours)**
  Concept need and scope of entrepreneurship, characteristic of entrepreneurship, forms of business organization.

- **IPR AND PATENT ACT (03 Hours)**
  Importance and scope, forms of IPR, patents, copy rights, trademarks, relevant acts.

(Total Lectures: 45 hours)

3. Books Recommended

11. B S Patil, Civil Engineering Contracts and Estimates, 4" Edition, Orient BlackSwan Pvt. Ltd., Hyderabad, 2015.
12. B N Dutta, Estimating and Costing in Civil Engineering (Theory and Practice), 28'h Revised Edition, UBS Publishers' Distributors Pvt. Ltd., New Delhi, 2016.
13. R H Namavati, Professional Practice, 1st Edition, Lakhani Book Depot, Mumbai, 2016.
14. S K Guha Thakurta and K R Shah, Manual of Construction Project Management, 1st Edition, Multi-tech Publishing Co., Mumbai, 2003.
15. K N Jha, Construction Project Management: Theory and Practice, Pearson Education, New Delhi, 2015.

4. Mapping of COs and POs

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

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

CE334 Air Pollution and Control

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 concepts of air pollution sources and air pollutants.
CO2	Explain standards and legislation pertaining to air and noise pollution.
CO3	Understand the fate of pollutants through meteorology.
CO4	Explain the use of different air quality models for predicting air quality
CO5	Design air pollution control devices for particulate pollutants.

2. Syllabus

- **SOURCES, MEASUREMENT AND ANALYSIS (05 Hours)**
  Important air pollutants, their sources, characteristics and effects. Sampling and Analysis, Ambient air sampling, stack sampling, Air quality standards.
- **AIR QUALITY AND STANDARDS (05 Hours)**
  Ambient air sampling, stack sampling, Air quality standards.
- **AIR POLLUTION METEOROLOGY AND DISPERSION MODELS (15 hours)**
  Atmospheric motion, lapse rate, atmospheric stability, inversion, atmospheric dispersion, maximum-mixing depth, diffusion models, plume rise, effective and minimum stack height.
- **AIR POLLUTION CONTROL (15 hours)**
  Characteristics of particulates. Filters, gravitational, centrifugal-multiple type cyclones, prediction of collection efficiency, pressure drop, Wet collectors, Electrostatic Precipitator theory-particle charging-particle collection-ESP design procedure. Control of gaseous pollutants. adsorption, absorption. Emission control in coal-fired power plants and other important industries. Condensation and incineration
- **OTHER TOPICS (05 hours)**
  Noise pollution and control, odour pollution and control, indoor air pollution

(Total Lectures: 45 hours)

3. Books Recommended

1. H D Nevers, Air Pollution Control Engineering, McGraw-Hill, New York, 2000.
2. K Wark, C F Warner and W Davis, Air Pollution: Its Origin and Control, Harper and Row, New York, 1998.
3. M N Rao, Air Pollution, Tata McGraw Hill, New Delhi, 2004.
4. R D Griffin, Principles of Air Quality Management, CRC Press, Boca Raton, 2006.
5. H S Peavy, D R Rowe and G Tchobanoglous, Environmental Engineering, McGraw-Hill , New Delhi,

2004.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 365 Ground Improvement Techniques

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	Illustrate the principle of ground improvement and identification of weak deposit
CO2	Identify the Geosynthetics and its application in Civil Engineering Project
CO3	Execute the ground improvement using stabilization and grouting technique
CO4	Design the ground improvement methods as per site requirements using national/international codal guidelines
CO5	Design of stone column and sand drain/PVD as per codal guidelines

2. Syllabus

- **INTRODUCTION** **(05 Hours)**
  Role of ground improvement in foundation engineering, Weak deposit, Classification of Ground Improvement Techniques, Principle of Ground Improvement, Factors affecting selection of Ground improvement Techniques.

- **HYDRAULIC MODIFICATION** **(08 Hours)**
  Methods of Dewatering, Design steps of Dewatering systems, Precompression and Vertical drain, Pre loading with sand drains. Radial consolidation combined vertical and radial consolidation.

- **IN-SITU DESIFICATION OF SOIL** **(10 Hours)**
  Dynamic compaction, Design of dynamic compaction by FHWA guidelines, Vibrotory compaction in sands, Vibroflotation, Blasting, Vibro compaction piles, Stone Columns, Methods of Installation of stone column, Design of stone column as per IS:15284.

- **EARTH REINFORCEMENT** **(12 Hours)**
  Geo-synthetics, Geo-synthetics applications of reinforced earth. Different types of walls like wrap-around walls, full-height panel walls, discrete-facing panel walls, modular block walls. Design methods as per ASD method, construction of steep slopes with reinforcement layers on competent soils.

- **GROUTING AND STABILIZATION** **(10 Hours)**
  Grouting principle and design, Suitability of methods of stabilization and Grouting, Suspension and solution grout, Injection methods, electrochemical stabilization, Stabilization with cement, lime and chemicals, stabilization of expansive clays.

(Total Lectures: 45 hours)

3. Books Recommended

1. J Han, Principles and Practice of Ground Improvement, John Wiley & Sons, New Jersey, 2018.
2. M R Hausmann, Engineering Principles of Ground Modification, McGraw Hill Publishing Company, New York, 2013.
3. K Kirsch, A Bell, Ground Improvement, CRC Press, Boca Raton, 2012.
4. S K Gulhati and M Datta, Geotechnical Engineering, Tata McGraw-Hill Education, New Delhi, 2017.
5. S Mittal, An Introduction to Ground Improvement Engineering, Medtech, Delhi, 2013.
6. Design guidelines from IS code, FHWA, BS and other codal organizations.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 378 Introduction to Earthquake Geotechnical 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	Illustrate the basic concept of the geotechnical earthquake engineering and identify the basic competence in assessing seismic hazard and in characterising earthquake actions
CO2	Identify and select various seismic terminology, measurements and geotechnical aspects of earthquake engineering
CO3	Determine the dynamic soil properties using basis of the wave propagation theory
CO4	Evaluate various earthquake forces for different geotechnical structures
CO5	Predict the behaviour and design the foundation subjected to earthquake loading

2. Syllabus

- **INTRODUCTION TO GEOTECHNICAL EARTHQUAKE ENGINEERING** **(02 Hours)**

  Scope and objective, Nature and types of earthquake loading, Importance of Geotechnical Earthquake Engineering

- **SEISMOLOGY AND EARTHQUAKES** **(08 Hours)**

  Engineering Seismology Basic Seismology, Earthquake, List of major earthquakes, Causes of earthquakes, Sources of earthquake data, Faults, Plate tectonics, Seismograph and Seismogram, Prediction of Earthquakes, Protection against earthquake damage, Origin of Universe, Layers of Earth, Theory of Continental Drift, Hazards due to earthquakes

- **STRONG GROUND MOTION (PARAMETERS AND ESTIMATION (09 Hour)**

  Strong Ground Motion Size of Earthquake, Magnitude and Intensity of Earthquake, Modified Mercalli Intensity Scale, Measuring of Earthquake, Earthquake Magnitude Local (Richter) magnitude, surface wave magnitude, Moment magnitude, Seismic energy, Correlations. Spectral Parameters: Peak Acceleration, Peak Velocity, Peak Displacement, Frequency Content and duration.

- **SEISMIC HAZARD ANALYSIS** **(05 Hours)**

  Identification of seismic sources, Deterministic and Probabilistic Analyses

- **WAVE PROPAGATION (1D AND 3D)** **(05 Hours)**

  Elastic response of continua, one dimensional Waves in layered media, Mohorovicic discontinuity and Gutenberg Discontinuity, Seismic Travel Time Curve, Three Circle Method for locating an Earthquake's Epicentre

- **DYNAMIC SOIL PROPERTIES AND GRA** **(08 Hours)**

  Laboratory and Field Determination, Correlations of different soil parameters, Liquefaction (basics, evaluation and effects), Liquefaction hazard map, Lateral Spreading, Ground response analysis, Local site effects and Design ground motions.

- **CASE STUDIES IN EARTHQUAKE GEOTECHNICS (08 Hours)**
  Seismic Analysis and Design of Various Geotechnical Structures, Pseudo-static method, Pseudo dynamic method, other dynamic methods, Seismic slope stability analysis, Behaviour of reinforced soil under seismic conditions, seismic design of shallow foundations, seismic design of pile foundations, seismic uplift capacity of ground anchors, Codal provisions/guidelines for seismic design of geotechnical structures.

(Total Lectures: 45 hours)

3. Books Recommended

1. B A Bolt, Earthquakes, Centennial Update, W. H. Freeman, New York, 2005.
2. S L Kramer, Geotechnical Earthquake Engineering, Prentice Hall, New Jersey, 1996.
3. I Towhata, Geotechnical Earthquake Engineering, Springer, Berlin, 2008.
4. M Srbulov, Geotechnical Earthquake Engineering Simplified Analyses with Case Studies and Examples, Springer, Dordrecht, 2008.
5. D Day, Geotechnical Earthquake Engineering Handbook, McGraw-Hill, New York, 2012.

4. Mapping of COs and POs

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

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

CE 342 Design of Formwork

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	Illustrate the requirement of formwork; classify the formwork systems and their selection; and choose the appropriate material.
CO2	Determine the expected loads on formwork systems and calculate the permissible values.
CO3	Design of formwork systems for the construction of various structural members.
CO4	Analysis of load distribution on shores and slabs in multi-story building frames.
CO5	Analysis the causes of formwork failures and find their preventive measures; study the applications of various special formwork.

2. Syllabus

- **INTRODUCTION (06 Hours)**

  Formwork and falsework; Requirement of formwork; Selection of formwork; Classifications of formwork; Materials for formwork

- **FORMWORK DESIGN CONCEPTS (03 Hours)**

  Loads on formwork systems; Design aspects and assumptions; Permissible stresses and deflections as per IS codes

- **FORMWORK FOR FOUNDATIONS AND WALLS (08 Hours)**

  Various components of formwork for foundations and walls and their design; Proprietary wall formwork systems

- **FORMWORK FOR COLUMNS (05 Hours)**

  Various components of formwork for columns and their design; Proprietary column formwork systems; Disposable column formwork

- **FORMWORK FOR BEAMS AND SLABS (08 Hours)**

  Various components of formwork for beams and slabs and their design; proprietary beam and slab formwork systems

- **FORMWORK IN MULTI-STORY BUILDING CONSTRUCTION (08 Hours)**

  Shoring, reshoring, back-shoring and pre-shoring; Striking and cycle time; Simplified analysis and their assumptions and limitations; Load distribution on shores and slabs in multi-story building frames; Calculating the strength of the concrete slab at a given point in time

- **FORMWORK FAILURES (02 Hours)**

  Causes of formwork failures; Deficiencies in designing; Preventive measures; Safety in formwork operations

- **SPECIAL FORMWORK (05 Hours)**

Flying formwork: table forms, tunnel formwork, column-mounted shoring systems, gang forms; Slip formwork; Formwork for precast concrete; Formwork for bridge structures

(Total Lectures: 45 Hours)

- ***TUTORIAL:*** **PREDICTION OF LATERAL PRESSURE OF CONCRETE (02 hours)**
  Prediction of lateral pressure of concrete on various components of formwork systems using (i) CIRIA (Construction Industry Research and Information Association); (ii) ACI (American Concrete Institute); (iii) DIN (Deutsche Institut für Normung); and IS (Indian Standard) methods

- ***TUTORIAL:*** **DESIGN OF VARIOUS COMPONENTS IN FORMWORK SYSTEMS (08 hours)**
  Design of sheeting, wales, studs, stringers, joists/battens, shores, ties for the formwork systems for the footings, columns, walls, beams and slabs.

- ***TUTORIAL:*** **LOAD DISTRIBUTION IN SLABS AND SHORES (05 hours)**
  Determine load distribution in slabs and shores for one, two, three and four levels of shores; two levels of shores and one level of reshores with the following loading conditions (i) Dead load only; and (ii) Dead load and construction live load.

(Total Tutorials: 15 Hours)

3. Books Recommended

1. Jha, K.N., Formwork and scaffold Engineering, First Edition, Pearson India Education Services Private Limited, 2023.
2. Jha, K.N., Formwork for concrete structures, Second Edition, McGraw Hill Education, 2017.
3. Peurifoy, R.L. and Oberlender, G.D., Formwork for concrete structures, McGraw Hill, 2011.
4. Raghavan, K.P., Natarajan, S. and Tamilarasu, V., Formwork management in construction, Khanna Book Publishing, 2024.
5. Brett, P., Formwork and concrete practice, Butterworth-Heinemann Ltd, 1988.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 344 Design of Industrial Structures

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	Classify the various industrial structures considering the statutory requirements.
CO2	Establish the relationship between various design parameters, analyse and design the components of industrial buildings and gable frames.
CO3	Analyse and design the long span structures, silos and bunkers.
CO4	Analyse and design the towers and masts.
CO5	Evaluate the design parameters to design the foundation for industrial structures

2. Syllabus

- **PLANNING OF INDUSTRIAL STRUCTURES (07 Hours)**
  Classification of industries and local regulations - Factors affecting planning - General Aspects - Civil Engineering Aspects - Light and Ventilation.

- **DESIGN OF INDUSTRIAL STRUCTURES (13 Hours)**
  Types of Loads - Structural configurations - Components of a typical industrial building and overview of design procedure - Analysis of industrial buildings and Gable frames - Analysis of columns supporting Crane Girders.

- **LARGE SPAN STRUCTURES (09 Hours)**
  Cable roofs - Types of cable roofs - Analysis of a cable subjected to concentrated loads and uniformly distributed load - Complexities in the analysis of a cable roof - Overview of deep beams, Virrendel Girder, Castellated Girders - Introduction to earthquake effects

- **SILOS AND BUNKERS (08 Hours)**
  Concept of Angle of Repose - Pressure distribution - Dynamic loads - Stability of bunkers - Foundations

- **TOWERS and MASTS (04 Hours)**
  Types of towers and masts - Indian Standards Requirements - Analysis and Design

- **FOUNDATIONS FOR INDUSTRIAL STRUCTURES (04 Hours)**
  Machine foundations - General requirements - Design criteria - General analysis - Design of a block foundation for vertical compressor - Vibration Isolation - Foundations for Chimney and Microwave Towers.

(Total Lectures: 45 hours)

3. Tutorials

The students will be required to solve at least five examples and related theories from each topic as part of their assignment or tutorial. This helps students gain experience in implementing analysis and design of various real-life problems applied in the field of structural engineering.

(Total Tutorials: 15 hours)

4. Books Recommended

16. N Subramanian, Steel Structure Design Practice, Oxford Press, Oxford, 2013.
17. M R Shiyekar, Limit State Design in Structural Steel, PHI Learning Private Ltd., Delhi, 2013.
18. P Srinivasula, Handbook of Machine Foundation, First Edition, Tata McGraw Hill Publications, New Delhi, 2000.
19. Ramchandra and V Gehlot, Design of Steel Structures, Seventh Edition, Standard Book House, New Delhi, 2017.
20. M Raghupati, Design of Steel Structures, First Edition, Tata McGraw Hill Publication, New Delhi, 2003.

4. Mapping of COs and POs

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

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

CE 346 Structural Vibration Control

L	T	P	C
3	1	-	4

1. Course Outcomes (COs)

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

CO1	Understand different types of seismic hazards
CO2	Comprehend different types of structural control methods
CO3	Design a stable structural configuration for vibration control
CO4	Design a vibration control technique for different types of dynamic induced loadings
CO5	Describe about different types of energy dissipating devices.

2. Syllabus

- **SEISMIC HAZARD (15 Hours)**
  Different types of Seismic Hazard, Mitigation of Seismic Hazard, Continental Drift and Plate Tectonics, Elastic Rebound Theory, Deterministic Seismic Hazard analysis, Probabilistic Seismic Hazard analysis, Effects of local Site Conditions on Ground Motion, Liquefaction.

- **STRUCTURAL CONFIGURATION FOR VIBRATION CONTROL (15 Hours)**
  Structural Configuration for wind and seismic vibration control, Concept of plan irregularities, soft storey, Torsion in buildings, Design provisions as per Indian codes, The effect of infill masonry walls on frames. Modelling concepts of infill masonry walls, Behaviour of masonry building during earthquake.

- **SEISMIC CONTROL OF STURCTURES (15 Hours)**
  Passive control, hybrid control, semi active control, Principle of base isolation, Theory of vibration isolation, Components of base isolation, Linear and Nonlinear procedures of isolation design, Application of theory to multiple degree of freedom system, Laminated rubber bearing, lead rubber bearing, high damping rubber bearing, friction pendulum system, Modelling of isolation bearings, Design process for multilayered elastomeric bearings and buckling behaviour of elastomeric bearings, Isolation system testing, Metallic yield dampers, friction dampers, viscoelastic dampers, tuned mass dampers, tuned liquid dampers, Shape memory alloy dampers, Application to multistorey buildings.

(Total Lectures: 45 hours, Tutorials: 15 hours)

3. Tutorial

The theoretical questions and numerical will be given as assignment to the students based on theory

4. References

1. Chopra, A.K., "Dynamics of Structures – Theory and Applications to Earthquake Engineering", 4th Edition, Pearson Education, 2011
2. Ashok K.Jain, "Dynamics of Structure with MATLAB Applications", Pearson, 2017.
3. Datta, T. K. "Seismic analysis of structures". John Wiley & Sons, 2010

4. Suhasini Madhekar and Vasant Matsagar “Passive Vibration Control of Structures”, Routledge, 2020 . 5. Ou, J. “Structural Vibration Control: Active, Semi-active and Intelligent Control”, 2004

5. Mapping of COs and POs

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

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

6. Mapping of COs and PSOs

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

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

CE 348 Public Transport 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	Synthesize urban growth with transit system needs.
CO2	Plan and execute appropriate transit data collection scheme.
CO3	Generate transit demand patterns and design the system.
CO4	Analyse the demand and recommend suitable network size and configuration for transit.
CO5	Carry out performance evaluation of transit operations.

2. Syllabus

- **TRANSIT SYSTEMS (08 Hours)**
  Growth history- Urban growth & transit evolution - Types of Transit Modes - Buses - LRT, RTS Air cushioned and Maglev System - S-Bahn Dual Mode Busses, Para Transit - Dial - a- Ride- Taxi- Jitney and Ridesharing- PRT Networks -DRTS Technological Characteristics Resistances, acceleration & velocity Profiles- Operational characteristics speed, capacity & payloads- Route capacity- Comfort conditions - Performance relationships - Public and Private Operations – Modes for Intercity Transport.

- **ESTIMATION OF TRANSIT DEMAND (06 Hours)**
  Data requirements & Collection techniques, Conventional Methods - Destination Survey - Transit Stop & Ride Surveys and Analysis - Mode Split Models - Captive and Choice Riders - Attitudes of Travelers - Patronage Determination.

- **TRANSIT DESIGN (06 Hours)**
  Frequency & headway determination methods- Rail operation design- Bus operation design - Way capacity & Station capacity- Transit level of service.

- **TRANSIT ROUTE NETWORK PLANNING (08 Hours)**
  Route Systems - Route Location, Route Structure, Route Coding Techniques, Route Capacity - Planning of Transit Network - Different Types - Service Area Coverage - Evaluation - Selection of Optimal Network - Path Building Criteria - Integration with UTPS.

- **SCHEDULING (06 Hours)**
  Patterns of transit Services - Frequency of Services - Special Services - Single Route Bus Scheduling - Fleet Requirement, Marginal Ridership Concept - Use of Optimization Technique - Load Factor - Depot Location - Spacing of Bus Stops.

- **MASS TRANSIT CORRIDOR IDENTIFICATION AND PLANNING (06 Hours)** Corridor identification - Network Compression Method - Planning of Rapid Transit System - System Selection - Aesthetics and Noise Consideration - Cost of Construction - Station Arrangements - Platform Capacity - Fare Structure, Transit Marketing.

- **TRANSIT TERMINALS AND PERFORMANCE EVALUATION (05 Hours)** Performance Evaluation- Efficiency, Capacity, Productivity and Utilization- Performance Evaluation Techniques and Application- System Network Performance- Transit Terminal Planning and Design.

(Total Lectures: 45 hours)

3. Books Recommended

1. A Ceder, Public Transit Planning and Operation: Theory, Modelling and Practice, B-H Elsevier Ltd., Massachussets, 2007.
2. C J Khisty, L B Kent, Transportation Engineering An Introduction, Prentice-Hall, New Jersey, 2005.
3. C S Papacostas and P D Prevedouros, Transportation Engineering & Planning, PHI, New Delhi,2002.
4. V R Vuchic, Urban Public Transportation: Systems & Technology, John Wiley & Sons, New Jersey, 2007.
5. P Sarkar, V Maitry, G J Joshi, Transportation Planning Principles, Practices & Policies, PHI, New Delhi, 2014.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 352 OPERATION AND MAINTENANCE MANAGEMENT OF PAVEMENTS

L	T	P	C
3	1	0	4

Course Outcomes (COs)

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

CO1	Prepare Model Concession Agreement for various types of PPP models of project implementation for operation and maintenance of highways.
CO2	Assign the priorities of maintenance by identifying significant factors influencing the project.
CO3	Evaluate the functional and structural condition of existing pavement.
CO4	Identify the pavement distresses and suggest suitable maintenance strategies.
CO5	Design the overlays for the existing pavement using various approaches using BBD and FWD.

Syllabus

- **INTRODUCTION** **(05 Hours)** Operation and maintenance (O&M) of the Project Highway - Model Concession Agreement (MCA) for various types of PPP projects -Management and Organization - Project Cycle -Levels of Management - Administration and Logistics - Site Management Road Maintenance – Approach – Organization - Management Activities.

- **OPERATIONAL MANAGEMENT ACTIVITIES** **(08 Hours)** Road Inventory - Assessment of Maintenance Requirements – Drainage – Running Surface – Structures - Setting Priorities - Planning Maintenance Works – Implementation Work Activities and Task Rates - Tools for Maintenance Works - Reporting and Monitoring.

- **PAVEMENT EVALUATION** **(08 Hours)** General concept of pavement evaluation - Evaluation of pavement performance - Structural capacity – Distress – Safety.

- **PAVEMENT DISTRESS** **(08 Hours)** Structural and functional – serviceability - fatigue cracking - pavement deformation and low temperature shrinkage cracking - factors affecting performance - relation between performance and distress - Methods of performance surveys - Methods of measuring defects - Pavement – Life studies.

- **DISTRESS MEASURING EQUIPMENTS** **(08 Hours)**

  Functional and structural evaluation - Functions parameters such as roughness - Distress, rutting - Skid resistance etc. - structural parameters such as structural capacity - Benkelman beam - bump integrator

- demonstration of equipment's for dynamic testing of pavements (LWD) - pavement skid resistance measuring equipment's - fatigue testing equipment.

- **DESIGN OF OVERLAYS** **(08 Hours)** Types of Overlays - Design Methodologies - Flexible overlays - Rigid overlays – design of overlay by Benkelman beam and falling weight Deflectometer - Asphalt Institute Method - Portland Cement Association Method, -AASHTO Method.

(Total Lectures: 45 Hours)

Mapping of COs and POs

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

Mapping of COs and PSOs

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

BOOKS RECOMMENDED

1. R Hass, W R Hudson and J Zaniewski, Modern Pavement Management, Krieger Publishing Company, Melbourne, 1994.
2. Y H Huang, Design of Functional Pavements, Pearson Prentice Hall, Singapore, 2004.
3. E J Yoder, and M W Witczak, Principles of Pavement Design, John Wiley and sons, New Jersey, 1975.
4. L R Kadiyali, Principles & Practice of Highway Engineering, Khanna Publishers, New Delhi, 2003.
5. Relevant IRC code & Infrastructure development form Planning commission of India Publication, MoRTH Publications.

	L	T	P	C
CE 354 TRAFFIC FLOW THEORY	**3**	**0**	**0**	**3**

CO1: Comprehend, represent and analyze the variation of traffic flow characteristics at microscopic and macroscopic levels using trajectory data
CO2: Recognize various car-following theories for identifying key factors affecting driving behavior and traffic performance
CO3: Evaluate traffic stability and efficiency for varying roadway and traffic conditions by means of design and control parameters
CO4: Solve real world transportation problems using queuing theory
CO5: Apply programming and simulation skillset to interpret and analyze data pertaining to traffic and transportation engineering problems

- **TRAFFIC STREAM CHARACTERISTICS (10 Hours)**

Measurement of microscopic and macroscopic traffic flow characteristics using loop detectors; Time-space plots; density measurement techniques, gap acceptance behavior. Use of counting, interval and translated distributions for describing Vehicle Arrivals, Headways,driver reaction times, Speeds, Gaps and Lags under varying roadway and traffic conditions. Vehicle-following, lane-changing, lateral and longitudinal vehicular movements under homogeneous and heterogeneous traffic conditions, identifying vehicle-following pairs using vehicular trajectory data numerical simulation of car-following behaviour.

- **TRAFFIC STREAM MODELS (12 Hours)**

Fundamental Equation of Traffic Flow, continuity equation and its assumptions, Speed-Flow-Concentration Relationships(Fundamental and Macroscopic Fundamental Diagrams), Pedestrian stream models, Normalized Relationship, Fluid Flow Analogy Approach, Gas-kinematic models, Shock-Wave Theory, Car-Following Theory, Advanced Car-Following Models, Psycho-physical models, Traffic Flow Stability, Social-force models, Hysteresis based behavioral studies, two-fluid model, driver behaviour modelling under heterogeneous traffic conditions, Introduction to two-dimensional modelling approach.

- **SHOCKWAVE ANALYSIS: (06 Hours)**

Shock wave equations; Types of shockwaves and propagation; Shock waves at toll gates, Signalized intersections, Shockwaves due to incidents; Shockwaves due to bottlenecks, Shockwave analysis on flow-density diagram and using simulation.

- **QUEUING ANALYSIS (07 Hours)**

Fundamentals of Queuing Theory, Demand Service Characteristics, Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels, Models of Delay at Intersections and Pedestrian Crossings, Queuing examples and numerical analysis; Determination of number of servers, Average time and vehicles in Queuing system.

- **TRAFFIC SIMULATION: (10 Hours)**

Monte Carlo method; Generation of Pseudorandom Numbers; Discrete Random deviates; Simulation methods; Fundamentals of simulation, Introduction to factorial experimental designs, Fractional factorial design, Components of traffic simulations models, vehicle arrival and movement models, mixed traffic flow simulation, Simulation model development strategies; Study of large scale simulation models;

Scanning Technique; Time based and Even-based methods; Examples of Macroscopic, Mesoscopic, and Microscopic based simulation models, Calibration and Validation of Simulation Models; methodology for calibrating and validating a microscopic traffic simulation model; Case studies of application of simulation for various transportation engineering problems.

(Total contact hours: 45)

Mapping of COs and POs

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

Mapping of COs and PSOs

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

Note: 1: Slightly 2: Moderately 3: Substantially

REFERNCES

1. Boris S. Kerner, Introduction to Modern Traffic Flow Theory and Control, Springer; 1st Edition. Edition, 2009
2. Drew, DR., Traffic flow theory and control McGraw Hill Book Company, 1976.
3. Fred L. Mannering, Scott S. Washburn, Kilareski Walter P., Principles of Highway Engineering and Traffic Analysis, Wiley India Pvt Ltd., 4th edition, 2011.
4. Gerlough DL and Huber MJ. Traffic Flow Theorya Monograph: TRB special report 165, 1992.
5. Highway Capacity Manual, Transportation Research Board, Washington, D.C., 2010.
6. May, A.D. Traffic Flow Fundamentals, Prentice Hall, 1st Edition, 1990.
7. Mc Shane WR and RP Roess: Traffic Engineering Prentice Hall, 1998.
8. Roger P. Roess, E. S. Prassas and W. R. McShane, Traffic Engineering, Prentice Hall, 4th edition, 2010.
9. Barceló, J. "Models, Traffic Models, Simulation, and Traffic Simulation". Barceló, J. ed. Fundamentals of traffic simulation. New York: Springer, 2010.
10. Banks, J; Carson, JS; Nelson, B.L. Discrete-event system simulation. 5th ed. Upper Saddle River, NJ: Prentice-Hall, 2010.
11. Clifford S., E. S. Park, Laurence R. R., Transportation Statistics and Microsimulation, CRC Press, Taylor and Francis group, 2011.
12. Neylor, T.H. et al., Computer Simulation Techniques, John Wiley, 1966
13. Winnie Daamen, Christine Buisson, Serge P. Hoogendoorn,Traffic Simulation and Data: Validation Methods and Applications, CRC Press, 2014

14. Edward Chung, Andre-Gilles Dumont, Transport Simulation: Beyond Traditional Approaches, CRC Press, 2009.

CE356: RURAL PLANNING AND DEVELOPMENT

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 rural planning and development
CO2	Interrelate the concept of agriculture development
CO3	Review national policies and technologies used in rural development.
CO4	Recognize institutions and organization setup of rural areas.
CO5	Perceive the concept of Rurban and related terminology.

2. Syllabus

- **INTRODUCTION: (06 Hours)**

  Introduction: Meaning and Scope and overview of rural development: Historical perspective – Rural Development Programmes in India. Problem / perception and identification; Rural Area Planning – Programmes / Policies / Schemes for rural development, their coverage and outcomes;

- **RURAL PLANNING AND DEVELOPMENT: (08 Hours)**

  Programme of Rural planning and developments, Backward Area Development Programme, North Eastern Development Programme. Impacts and Implications of Rural policies on rural and urban development. Planning of village centre. Planning and management of village clusters. Low cost

- **PROFILE OF RURAL SETTLEMENTS: (06 Hours)**

  Definitions need growth, distribution and classification of rural settlements, size from function and morphology of rural settlements.

- **RURAL SETTLEMENT ANALYSIS: (06 Hours)**

  Types, activity, environment and economic interface in rural habitat, technology in rural settlement; Mobility between rural and Urban Areas.

- **TECHNOLOGY FOR RURAL PLANNING AND DEVELOPMENT: (09 Hours)**

  Understating different missions, ICT in rural development, Rural Information system, Weather forecasting, disaster minimization, market information, etc. E-Panchayats, energy efficient technologies and alternative technologies

- **RURAL INSTITUTIONS AND ORGANISATIONS: (10 Hours)**

  Rural bank, Co-operatives, marketing and public administration Zila Parishad, Block Semity and Gram-Panchayat, powers and function of recently proposed Panchayat Raj Bill., Panchayati Raj Institution (PRI) Various Programs, Hierarchy of Panchayati Raj Institution, White revolution and Economy change in Rural development. Export promotion and SEZ Zones are identified in rural areas

(Total Lectures: 45 Hours)

3. Books Recommended

1. Ramchandran H., Village Clusters and rural Development, Concept Publ. Co., New Delhi.
2. Planning Commission "Manual of Integrated District Planning 2006" Planning Commission, New Delhi

3. Government of India, “Various Five Year Plans (1st to 12th)” Planning Commission, New Delhi
4. Govt. of Kerala “Kollam Perspective Plan 2009” Department of Town & Country planning, Thiruvanantpuram
5. Cokke, B. and Kothari, U (Eds.) (2001), People’s Knowledge, Participation and Patronage, London: ZED Books.

4. Mapping of COs and POs

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

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

5.Mapping of COs and PSOs

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

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

CE358: URBAN LAND 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	Understand the significance of Urban Land Management.
CO2	Understand Land as Resources and its related terminology.
CO3	Postulate dynamics of Urban Land market.
CO4	Identify legal aspects of development and their impacts on real estate development
CO5	Apply land management techniques to manage urban growth

2. Syllabus

- **LAND MARKET DYNAMICS: (10 Hours)**

  Concept, Scope, Principles, Land Use and Land Value, Parameters of Land dynamics market mechanism and land use pattern, Land Revenue Code, Land use restriction; compensation and acquisition, Urbanisation and land price speculations

- **LAND ECONOMICS: (08 Hours)**

  Economics and Principles of land use, Development of land and real properties, Land Development charges and betterment levy PPP in urban land development & case studies

- **LAND POLICIES AND PRACTICES AND TECHNIQUES: (16 Hours)**

  Policy: Concept, Need, Objective, Significance, Factor influencing location decision, Analysis of location of specific land use like residential-industrial commercial and institutional in intra regional as well as inter regional level Case studies of various land use policies and practices at national, state, district and settlement level, Land acquisition and land pooling techniques, Process of virgin agricultural land converted into fiscal Resources

- **LEGAL ASPECTS: (11 Hours)**

  Provisions of Land Acquisition Act, Urban Land Ceiling Act and Conservation Act, Town planning Acts, Origin, Objectives and applications. Building Bye-laws-Formations, Provisions and implications. Impacts on real estate developments.

(Total Lectures: 45 Hours)

3. Books Recommended

1. Lall S. V. (2009), Urban Land Markets: Improving Land Management for Successful Urbanization, Springer.
2. Randolph J. (2012), Environmental Land use planning and Management,2nd ed, Island Press.
3. Berke P. R. (2009), Urban Land use Planning, 5th ed, Chicago: University of Illinois Press.
4. Deakin M.(2016), 'Meethodologies, Models and Instruments for Rural and Urban Land Management', Routledge
5. Christopher C, (2011), 'Growth Management and Public Land Acquisition: Balancing Conservation and Development', Routledge

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE362 HOUSING

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 housing forms and their relationship with urban areas.
CO2	Review the policies, norms, bylaws, and housing schemes in the Indian context.
CO3	Discuss housing scenarios, housing finance, the housing market, and the role of stakeholders
CO4	Compare housing typologies in the context of different climatic conditions
CO5	Design and plan residential areas considering socio-economic factors.

2. Syllabus

- **PLANNING OF RESIDENTIAL AREAS:** (**10 Hours**)

  Household and housing, housing requirement for different sections of society, building byelaws, development controls, housing projects layouts, Neighbourhood planning, design standards and their significance in housing process, socio-economic and aesthetic, environmental factors affecting layouts, various concepts of layout planning, row and multi storied housing, layout optimization techniques, appropriate DU design.

- **HOUSING FOR URBAN POOR:** (**09 Hours**)

  Process of slum formation, causes and consequences, approaches to tackle the Challenge of slums. Housing Evaluation for urban Poor, Aerial and cluster standards, materials, social amenities and services, locational parameters, Policies. Housing schemes, relocation, rehabilitation, in-situ upgradation, etc.

- **HOUSING POLICIES & FINANCE:** (**12 Hours**)

  Housing policies, Co-operative housing, Role of Central, State, Urban Local Bodies private and public sectors. Roles of financing institutes, Housing Boards, HUDCO, NHB, HFIs, various international donor/financing agencies, micro finance institutions, rural housing finance.

- **HOUSING MARKETS:** (**08 Hours**)

  Concepts and definitions of housing market, area, the purpose and nature of housing market studies; factors affecting housing prices, housing market behaviour, estimation of housing need, housing demand ,The formal and informal housing markets and their impact on urban poor, public, Co-operative and private sector.

- **CASE STUDIES:** (**06 Hours**)

  Case studies of housing projects at National and International Level, Housing for different climatic conditions, institute housing, Mass Housing, Affordable Housing, Transit and Temporary Shelters, Integrated Housing Schemes energy efficient design, Methodology for formulation of housing projects.

(Total Lectures: 45 Hours)

3. Books Recommended

1. Dwivedi R. M., (2007), "Urban development and housing in India 1947-2007" New Century Publications, New Delhi.

2. James A. LaGro Jr. (2008), "Site Analysis A Contextual Approach to Sustainable Land Planning and Site Design", John Wiley and Sons,Inc., Hoboken, New Jersey
3. Khanna P. N., (2019), "Indian Practical Civil Engineers Handbook", Engineers Publishers
4. Goswami D., (2012), "Housing and Urban Poverty Alleviation", SAAD Publications, Delhi
5. Kishor C. (2008), "Informal Sector: Concept, Dynamics, Linkages & Migration", Concept Publishing Company, New Delhi.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 364 Fundamental of GIS and Remote Sensing	L	T	P	Credit
	3	0	2	04

1. Course Outcomes (COs)

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

CO1	Explain the fundamentals of Remote Sensing
CO2	Identify digital image processing.
CO3	Explain fundamentals and processes of GIS.
CO4	Create different types of database.
CO5	Solve complex civil engineering problems using GIS and RS

2. Syllabus

Introduction **(04 Hours)**

Basics of GIS and Remote Sensing, Usefulness in Civil Engineering

Fundamental of Remote Sensing **(08 Hours)**

Basics of Remote Sensing, Components of Remote Sensing, Principles of Remote Sensing, Energy Sources, Active and Passive Remote Sensing System, Electro Magnetic Radiation (EMR) and the Electromagnetic Spectrum, Interaction of EMR with the Earth's Surface and the Atmosphere, Various types of images and their uses, Usefulness in Civil Engineering

Image Interpretation and Classification **(08 Hours)**

Types of Satellite Imagery, Interpretation Procedure, Strategies, Keys, Equipment's, Image Resolutions, Classification and Analysis of Image, LULC Mapping, Concept of Image Processing, Rectification and Restoration, Enhancement of Image

Fundamental of Geographic Information System (GIS) **(08 Hours)**

Overview of GIS, Geographical concepts and terms, Working pattern of GIS, Applications and benefits of GIS, Usefulness in Civil Engineering

GIS Data Sets and Data Models **(08 Hours)**

Input data to GIS, Digitization and scanning from maps, Input from satellite images and from GPS, Registration of Image, Thematic layers and Projection System of Layers

Spatial Data Models and Structures, Raster and Vector Data, Conversion, Storage and Compression Techniques, Database creation, Spatial and non-spatial Data, Database retrieval and management, Query from database

Geospatial Analysis **(04 Hours)**

Methods, Measurements, Analysis, GIS analysis functions, Implementation of GIS, Geovisualization

Software and Applications **(05 Hours)**

Study of Softwares related to RS and GIS, Salient features, Capabilities and Limitations, execution of Software and use of different tools in various applications in Civil Engineering like Flood Control, pollution parameter, conservation of natural sources, Traffic flow management and coastal zone management

(Total Lecture Hours: 45)

3. PRACTICALS / DRAWING*:

6. Study of different types of Stereoscopes and Stereo pairs
7. Study of various types of Satellite Images and its Interpretation

8. Study of ERDAS imagine Software's salient features and utility of different tools
9. Conversion of Image in to one format to another format
10. Preparation of Mosaics using ERDAS Imagine Software
11. Preparation of LULC mapping from the given image
12. Study of ArcGIS Software's salient features and use of different tools
13. Delineation of the given area using ArcGIS (Digitization)
14. Registration of satellite images using ArcGIS
15. Preparation of Digital Elevation Model from Contour
16. Preparation of Digital Elevation Model from Spot Heights (R.L.)
17. Preparation of 3D view of the area from DEM

4. BOOKS RECOMMENDED:

1. T M Lillesand and R W Kiefer, Remote Sensing and Image Interpretation, John Willey, New York, 2015.
2. P A Burrrough and R A McDonnel, Principles of Geographic Information Systems, Oxford university press, 1998.
3. A M Chandra and S K Ghosh, Remote Sensing and Geographical information System, Narosa Publishing House, New Delhi, 2006.
4. B Bhatta, Remote Sensing and GIS, Oxford University Press, New Delhi, 2008.
5. Stan Aronoff, Geographical Information Systems, WDL Publications, Ottawa, Canada, 1989.

Mapping of COs and POs

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

1-Low 2-Moderate 3-High

Mapping of COs and PSOs

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

1-Low 2-Moderate 3-High

CE 366 IRRIGATION AND DRAINAGE SYSTEMS ENGINEERING	L	T	P	Credit
	3	0	0	3

1. Course Outcomes (COs)

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

CO1	Select appropriate irrigation technique.
CO2	Describe Soil-Water-Crop Relationship
CO3	Develop suitable models for various irrigation methods.
CO4	Design drainage system for irrigated lands.
CO5	Apply soil conservation measures and reclamation of salt affected land.

2. Syllabus

INTRODUCTION (06 Hours)
Water resource in India and its present utilization, Development through five year plans, Roles of various commissions on irrigation and agriculture, National water policy, Types of irrigation, Irrigation methods and quality of irrigation water.

SOIL-WATER-CROP RELATIONSHIP (08 Hours)
Determination of soil moisture, Estimation of consumptive use and frequency of irrigation, Irrigation efficiencies for economical use of water, Design of various irrigation methods, Assessment of water charges, Conjunctive use of surface and ground water, Multi-crop irrigation scheduling.

MODELLING OF IRRIGATION SYSTEMS (08 Hours)
Governing equations and their solutions, Computation of inundation front, Cumulative infiltration estimation, Modelling for sprinklers and other methods of irrigation, Water Audit in irrigation systems.

SALT-AFFECTED LAND AND ITS RECLAMATION (08 Hours)
Salt accumulation in soil water, Classification of salts affecting the soils and their characteristics, Reclamation of saline and alkaline soils, Leaching and salinity control.

DRAINAGE OF IRRIGATED SOILS (08 Hours)
Need and purpose of drainage, Water logging of agricultural land and its reclamation, Steady state and transient designs of surface and sub-surface drainage systems, Drainage by wells.

SOIL EROSION AND CONSERVATION (07 Hours)
Water and wind erosion, Design of various types of soil conservation measures.

[Total Hours: 45 Hours]

3. References:

1. Asawa, G. L., "Irrigation and Water Resources Engineering", New Age International Publishers, New Delhi, 2005.
2. Yaron, D., "Salinity in Irrigation and Water Resources", Morcel Dekker Inc. New York, 1981.
3. Michael A. M., "Irrigation Theory and Practice", S Chand publication, New Delhi, 2008 (Second Edition).

4. Richard, H., and Cuenca, “Irrigation System Design: An Engineering Approach”, Prentice Hall, Englewood Cliffs, New Jersey, 1989.
5. Majumdar, D. K., “Irrigation Water Management Principles and Practice”, PHI Publication New Delhi, 2013(Second Edition).
6. Central Water Commission,, “Guideline for Computing the Water Use Efficiency [WUE] of the Irrigation Projects, Performance Overview & Improvement Organisation, CWC.

5. Mapping of COs and POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	2	1	1	2	3	1	1	1	2	3
CO-2	3	1	1	2	3	2	3	3	1	2	2	2
CO-3	3	3	3	3	3	1	1	3	2	2	2	2
CO-4	1	1	1	1	1	2	3	1	2	3	3	3
CO-5	1	1	2	3	3	2	1	1	3	2	3	2

1-Low 2-Moderate 3-High

6. Mapping of COs and PSOs

	PSO-1	PSO-2	PSO-3
CO-1	2	3	1
CO-2	2	3	1
CO-3	3	1	2
CO-4	1	2	3
CO-5	3	1	3

1-Low 2-Moderate 3-High

CE 372

Ground Water Engineering

L	T	P	Credit
3	0	0	3

1. Course Objectives

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

CO1	Explain the occurrence of ground water
CO2	Understand the principles of well hydraulics and computation of aquifer yield
CO3	Identification and conceptualization of Artificial recharge of ground water and Groundwater modeling techniques
CO4	Analyse the problem of salt water intrusion
CO5	Assess transport of pollutants in ground water

2. Syllabus

INTRODUCTION **(08 Hours)**

Occurrence of ground water, geological formations as aquifers, types of aquifers, ground water movement, Darcy's law, permeability and its measurement, tracing of ground water movement, fundamental equations for steady and unsteady ground water flow, flow nets, Ground Water Scenario of India.

WELL HYDRAULICS **(15 Hours)**

Steady and unsteady flow in confined, semi-confined and unconfined aquifers, radial flow, superposition, multiple well system. Different methods of well construction; construction of well casings and screens, natural and artificial gravel packed wells. Safe yields, estimation, pumping and recuperation tests, Infiltration galleries.

ARTIFICIAL RECHARGE OF GROUND WATER **(05 Hours)**

Ground-water replenishment, Artificial recharge of ground water, different methods, merits, demerits, selection criteria for various methods, cone of depression.

GROUNDWATER MODELING TECHNIQUES **(08 Hours)**

Porous media models, analog models, electric analog models, digital computer models

SALT WATER INTRUSION **(05 Hours)**

Concept, interface and its location, control of intrusion.

POLLUTANT TRANSPORT IN GROUND WATER **(04 Hours)**

Pollutant transport, Plume Transport, source identification, tracer methods.

[Total Hours: 45 Hours]

3. References:

1. Todd, D. K., and Mays, L. W., "Groundwater Hydrology",John Wiley publishers, 2011 (Third edition).
2. Bear J., "Hydraulics of Groundwater", Dover Publications, 2013.
3. Raghunath, H. M., "Groundwater and Well Hydraulics", New Age International Publishers, Delhi, 2007 (Third Edition)
4. Rastogi, A. K., "Numerical Groundwater Hydrology". Ulhas Phatak for Penra International (I) Pvt. Ltd., Mumbai, 2007.
5. Driscoll, F. G., "Groundwater and Wells", Johnson Filtration Systems Inc., Minnesota: 1986 (Second edition).

5. Mapping of COs and POs

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	1	2	3	2	3	1	1	2	1	1	2
CO-2	1	2	2	2	3	3	3	1	1	2	3	2
CO-3	2	1	2	2	3	1	3	2	3	3	3	1
CO-4	2	3	3	3	3	3	1	1	1	1	1	2
CO-5	3	1	3	2	1	1	1	1	2	3	3	2

6. Mapping of COs and PSOs

	PSO-1	PSO-2	PSO-3
CO-1	1	3	2
CO-2	2	3	3
CO-3	2	1	3
CO-4	1	3	3
CO-5	2	2	1

L	T	P	C
0	0	8	4

CE 374 Project I

Course Outcomes (COs)

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

CO1	Identify & formulate field problem related to the selected area of civil engineering and define the scope & objectives.
CO2	Synthesise relevant literature for solving the identified problem.
CO3	Develop the study methodology.
CO4	Carry out design of experiments related to field / laboratory / computational investigations.
CO5	Prepare comprehensive report on the preliminary activities related to the project and make its presentation.

Description

It will be taken up by the student at the end of the sixth semester and the duration would be of six months. This is aimed at engaging and empowering the students in hands-on learning. Enhancing their learning experience through mentoring relationships with faculty and provides them an effective career preparation direction and promotes interest in graduate education. The project report is expected to exhibit clarity of thought and expression, critical appreciation of the existing literature and analytical and /or experimental or design skill.

Mapping of COs and POs

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

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

Mapping of COs and PSOs

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

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

GLOBAL ELECTIVE/ELECTIVE 6
6th Semester, 3rd year

CE376 Waste-to-Energy Technologies

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	Analyze characteristics of solid wastes with respect to waste-to-energy technologies.
CO2	Compare between different waste-to-energy technologies with respect to its applicability.
CO3	Design simple systems based on anaerobic digestion process.
CO4	Design simple thermal waste to energy systems.
CO5	Explain the limitations and applications of different waste to energy options.

2. Syllabus

- **CHARACTERIZATION OF SOLID WASTES (10 hours)**

Wastes and their classification, Important quality parameters, Wastes suitable for energy production, Municipal solid wastes and their availability in India, Characterisation of solid wastes, proximate and ultimate analysis, leaching properties, Energy content and heating value

- **INCINERATION AND GASIFICATION (10 hours)**

Incineration scope and application, Mechanism, air requirements, Performance factors, Feedstock characteristics, Incinerator working, Environmental impacts and issues, Basics of gasification, gasification products, syngas, gasifier types, Gasifiers for biomass and wastes, Comparison between incineration and gasification, Syngas utilization

- **PYROLYSIS, GAS PURIFICATION (10 hours)**

Mechanism, types, operating conditions, end products, properties of biooil, Densification of solids, efficiency improvement of power plant and energy production from waste plastics. Properties of gas produced through different routes, Gas clean up, removal of particulates

- **ANAEROBIC PROCESSES (10 hours)**

Anaerobic processes fundamentals, microbiology, pathways, pre-treatment, types and operation of anaerobic digester, Design of anaerobic digesters, Introduction to microbial fuel cells. Energy production from wastes through fermentation

- **ALGAL BIOMASS FROM WASTEWATER AND ENERGY PRODUCTION (05 hours)**

Characteristics of algal biomass, Cultivation and growth of algae, Reactor systems and harvesting, Biooil production from algal biomass Conversion processes, factors affecting yield, homogeneous and heterogeneous catalyst.

(Total Lectures: 45 hours)

3. Books Recommended

1. M J Rogoff and F. Screve, Waste-to-Energy: Technologies and Project Implementation, Elsevier, Amsterdam, 2019.
2. G C Young, Municipal Solid Waste to Energy Conversion Processes, John Wiley and Sons, New Jersey, 2010.
3. J H Harker and J R Backhusrt, Fuel and Energy, Academic Press Inc., Cambridge, 1981.
4. H S Peavy, D R Row and G Tchobanoglous, Environmental Engineering, McGraw-Hill International Edition, New Delhi, 2012.
5. G Tchobanoglous and F Kreith, Handbook of Solid Waste Management, McGraw-Hill, New York, 2002.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 367 Soil Exploration and Field Tests

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	Comprehend the basics of site investigation methods and field tests and its extent for variety of structures including preliminary investigations.
CO2	Identify and suitable investigation method for soil exploration
CO3	Illustrate different specialized exploration methods based on condition and requirement
CO4	Appraise different codal provisions for field tests
CO5	Judge suitable instrumentation required for predicting the behavior of structure in soils and rocks

2. Syllabus

- **PRINCIPLES OF EXPLORATION** **(06 Hours)**
  Site investigation, objectives, Information required for soil investigation, Extent of Investigation for different types of structures (buildings, towers, industries, road, embankment, reservoir, Dams, retaining wall, etc.), Preliminary investigations.

- **BASICS OF EXPLORATION** **(07 Hours)**
  Modern methods of boring and sampling; Preservation and transportation of samples; Sampling records. Investigations in marine condition. Different disturbance in soil sampling. Sample collection, data logging and handling, Offshore investigation.

- **EXPLORATION METHODS** **(08 Hours)**
  Electric resistivity test, , gravimetric survey, , Seismic surveys like seismic refraction test, reflection test, multi-channel analysis of surface wave test, etc., Trial pits, disturbed and undisturbed sampling, detailed bore hole investigations: types of borings and types of samplers..

- **FIELD TESTS** **(08 Hours)**
  Plate load test, pile load test, SPT test, CPT test, flat dilatometer test, DCPT test, Vane shear test, pressure meter test, field CBR test, core cutter, sand replacement test, nuclear probe method, block shear test.

- **INTERPRETATIONSANDCODALPROVISIONS** **(08 Hours)**
  Soil profiling, interpretation of exploration data and report preparation, various standards for soil investigations.

- **INSTRUMENTATIONS** **(08 Hours)**
  Types of instruments used for Measurement of water table, pore pressure, LVDT, dial gauges, pressure gauges, non-contact-based settlement measurements Dissertation preliminaries should clearly identify the goals & objectives and scope of the dissertation work taken up by the candidate. The focus is on proposed numerical modelling/ experimental work/ field work. The study methodology and literature review on the dissertation topic is to be completed and a

typed report is to be finalized in consultation with dissertation supervisor and submitted and presented for the assessment at the end of the semester.

(Total Lectures: 45 hours)

3. Books Recommended

1. Clayton, C. R. I., Matthews, M. C. and Simons, N. E. (1995) Site Investigation (Second Edition). Oxford, Blackwell Sciences.
2. Hunt, R. E. (2005) Geotechnical Engineering Investigation Handbook (Second Edition), CRC Press Taylor & Francis Group.
3. Schnaid, F. (2009) In Situ Testing in Geomechanics: The Main Tests. Taylor & Francis.
4. Simons, N., Menzies, B. and Matthews, M. (2002) A Short Course in Geotechnical Site Investigation. Thomas Telford.
5. Dunnicliff, J. (1993) Geotechnical Instrumentation for Monitoring Field Performance. Wiley-Interscience Publication.

1. Mapping of COs and POs

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

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

2. Mapping of COs and PSOs

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

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

CE 382 Disaster Management

L	T	P	C
3	1	0	4

Course Outcomes (COs)

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

CO 1	Learning and understanding the basic knowledge of Disaster Management concept and different approaches to reduce the impact of disaster
CO 2	Understand the types of disaster their origin causes and their management and the disaster profile of India (NDMA and GSDMA)
CO 3	Explain the core elements and phase of disaster risk management and design mitigation preparedness to reduce disaster risk across sector and community
CO 4	Evaluate disaster management plans that determine the nature of disaster response and risk reduction action for various disasters.
CO 5	Explain various legislations and best practices for disaster management risk reduction an and national and international level

Syllabus

- **INTRODUCTION TO DISASTER (05 Hours)**

  Understanding and forecast of Hazard, Risk and Vulnerability in Disasters, Concept and evaluation of Risks, Climate change Risk (Natural & man-made factors), Risk and Vulnerability in Disasters

- **DEFINITION AND TYPES OF DISASTERS (08 Hours)**

  Classification of Disasters, (Natural and Man-made), Natural Disasters: Climatic Disasters (wind & water related): Tropical Cyclone, Floods & Drought. Earth related Disasters (Geological Disaster): Earthquake, Tsunami, Landslides & Volcano Eruption.

  Man-made Disasters: Industrial (on-site) Disasters: Toxic Gas leak, Explosion, Nuclear & chemical Disaster (BLEVE) Technological Disasters (Accidental Disasters): Rail, Road, Air & Sea. Ecological Disasters: Pollution, Soil Degradation, Loss of Biodiversity & Global warming. Epidemics: Cholera, Typhoid. Biological Disasters : COVID-19

- **STUDY OF IMPORTANT DISASTERS (05 Hours)**

  Earthquakes and its types, magnitude and intensity, seismic zones of India, major fault systems of India plate, flood types and its management, drought types and its management, landslide and its management case studies of disasters in India (e.g) Earthquakes, Landside). Social Economics and Environmental impact of disasters.

- **MITIGATION AND MANAGEMENT TECHNIQUES OF DISASTER (07 Hours)**

  Multi Hazard Mapping– Losses from Global Disasters and Expenses in Reconstruction and Retrofitting of structures; Basic principles of disasters management, Disaster Management cycle, Disaster management policy,

National and State Bodies for Disaster Management, Early Warning Systems, building design and construction in highly seismic zones, retrofitting of buildings.

- **DISASTER PREPAREDNESS AND TRAINING (07 Hours)**

  Disaster Management Bill, 2024, Training and drills for disaster preparedness, Awareness generation program, Role of Remote Sensing and Geographical Information System in Disaster management, Institutional Framework for Disaster Management, Role of Media, NGO, and Government, Emergency Planning, Basic Safety Measures (Pre and During): Earthquake & Floods.

- **DISASTER MANAGEMENT IN INDIA (05 Hours)**

  Structure of disaster management in India, NDM and Surat Disaster Management Specific challenges and strategies for disaster management in India. Success stories and best practices from Indian states.

- **INTERNATIONAL BEST PRACTICES (04 Hours)**

  Learning from global best practices in disaster management. Role of international organisations like the United Nations, World Bank, and Asian Development Bank.

- **VARIOUS CASE STUDIES (01 Hours)**

  Recent disasters in India: Floods, Cyclones like Fani and Amphan, Earthquake in Nepal. Analysis of disaster management strategies in these cases. Examples of cyclone disaster management, Fire Disaster Management, Industrial disaster management, medical disaster management and earthquake disaster management

(Total Lectures: 45 hours)

Books Recommended

1. R Subramaniam, Disaster Management**,** Vikas Publishing House, 2018
2. M.M. Sulphey, Disaster Management, PHI Learning, 2016
3. R Gaur, Disaster Management, 1st Edition Saujanay Books, Delhi, 2008.
4. G K Gosh, Disaster Management, Saujanay Books, Delhi, 2015.
5. S Modh, Citizen's Guide to Disaster Management: How to Save Your Own Life and Help, Macmillan India Ltd., Bangalore, 2006.
6. D P Coppola, Introduction to International Disaster Management, 3rd Edition, Butterworth Heinemann, Oxford, 2015.
7. Disaster Management in India, Ministry of Home Affairs, Government of India, New Delhi, 2011.

Mapping of COs and POs

	PO1	PO 2	PO 3	PO4	PO 5	PO 6	PO7	PO 8	PO 9	PO10	PO11	PO12
CO 1	1	1	1	1	2	2	1	1	1	1	1	1
CO 2	1	1	2	1	2	2	1	1	1	1	1	1
CO 3	1	1	2	3	2	2	2	1	2	1	2	2
CO 4	1	1	2	2	2	2	3	1	1	1	3	2

CO 5	1	1	2	2	2	1	3	1	1	1	3	2

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

Mapping of COs and PSOs

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

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

CE 384 Advanced Mechanics of Solids

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	Compare and analyze the fundamental properties of various materials.
CO2	Analyze the problems related to structural members subjected to different loadings using fundamental concepts of stress and strain.
CO3	Implement the concepts of failure theories to design various structural members.
CO4	Determining the stresses in curved bars for various sections.
CO5	Apply the strain gauges techniques to solve the real life engineering problem.

2. Syllabus

1. **Constitutive relations: (04 Hours)**
   Restrictions on constitutive relations, General relationship between Cauchy stress and Cauchy Green strain for isotropic materials, General Hooke's law and its reduction for isotropic and orthotropic materials.
2. **Complex stresses and strains: (05 Hours)**
   Stresses on an inclined plane in a plane-stress system, Principal stress, maximum shear stress, Mohr's circle for plane Stress, two-dimensional Strain Systems,
3. **Elastic theories of failure: (05 Hours)**
   Introduction, maximum principal stress theory, maximum principal strain theory, maximum shear stress theory, maximum strain energy theory, maximum shear strain energy theory, important points from theories of failures used in design.
4. **Strain Energy and impact loading: (04 Hours)**
   Expression for strain energy stored in a body when the load is applied gradually, suddenly and expression for strain energy stored in a body when the load is applied with impact, expression for strain energy stored in a body due to shear stress.
5. **Energy principle in solid continuum: (05 Hours)**
   Introduction to the Castigliano's first and second theorems and its applications, complimentary energy theorem, superposition theorem, reciprocal theorem, energy theorem, virtual work.
6. **State of stress caused by combined loading: (05 Hours)**
   Combined axial and bending (flexural) loads, combined torsion and axial loads, combined bending and torsion of circular shafts, combined bending, torsion, combined hoop and axial stresses on a pressure vessel, combined hoop and torsional shear stresses on a pressure vessel, procedure for analysis.
7. **Thin and thick cylinders and rotating discs: (06 Hours)**
   Thin cylindrical vessel subjected to Internal pressure, expression for circumferential Stress (or hoop stress), wire winding of thin cylinders, stresses in a thick cylindrical shell, rotating disc of uniform thickness, solid disc, solid disc with central hole, disc of Uniform Strength.
8. **Bending of curved bars: (05 Hours)**
   Assumptions made in the derivation of Stresses in a curved bar, expression for Stresses in a curved bar, determination of Factor "h2" for various sections, Resultant Stress in a curved bar Subjected to direct stresses and bending stresses, resultant stress in a hook, stresses in circular ring, Stresses in a chain link,

Winkler-Bach Formula, Elasticity solution for pure bending of curved beams, curved cantilever under end loading, Stresses in hook, stresses in curved bar with various sections.

9. **Instrumentation in the field problem: (06 Hours)**
   Applications of strain gauges in various engineering field, use of mechanical gauges, electrical strain gauges, rosette arrangements, Wheatstone bridge circuit, introduction to photo elasticity.

(Total Lecture Hours: 45 hours)

3. Tutorials:

The students will be required to solve at least five examples and related theories from each topic as part of their assignment or tutorial. It helps to gain experience to solve various real-life problems applied in the field of engineering.

(Total Tutorials: 15 hours)

4. Books Recommended

1. L S Srinath (2017), Advanced Mechanics of Solids, 3rd edition, Tata McGraw-Hill, New Delhi.
2. Adarsh Swaroop (2014) Mechanics of Materials, 2nd edition, New Age International Publishers.
3. Bichra B. Muvdi and Souhail Elhouar (2016), Mechanics of materials with application in excel, CRC press.
4. Prashant Kumar (2022), Mechanics of Materials: A Friendly Approach, World Scientific Publishing.
5. James W. Dally, William F. Riley (1991), Experimental Stress Analysis, 3rd international edition, McGraw-Hill Companies.

5. Mapping of COs and POS

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

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

6. Mapping of COs and PSOs

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

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

	L	T	P	C
CE 386 INTELLIGENT TRANSPORT SYSTEM	**3**	**0**	**0**	**3**

CO1: Identify various components of Intelligent transportation systems (ITS) and supporting technologies
CO2: Comprehend the role of ITS and its applications for improving the performance of the transportation system
CO3: Analyse automated traffic data collected using sensors for varying roadway and traffic conditions
CO4: Apply ITS related strategies for varying roadway and traffic conditions using design and control parameters
CO5: Evaluate ITS related strategies for improving the sustainability, efficiency and safety of transportation system considering different case studies

- **INTRODUCTION TO ITS (05 Hours)**

Definition Objectives, Historical Background, Benefits of ITS – Introduction to Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), Traffic control and monitoring aspects, components of ITS.

- **ADVANCED TRAVELER INFORMATION SYSTEMS (ATIS) (04 Hours)**

Trip Planner and its impact, Traffic density measurement, Variable message signs, Parking guidance, Weather information and variable speed limits, Impacts of ATIS.

- **ADVANCE VEHICLE MONITORING SYSTEMS (04 Hours)**

Security CCTV systems, Wireless Sensor Network and RFID, Blue-tooth and Wi-Fi sensors, inductive loop detectors and image processing techniques, Impacts of AVMS

- **COMMERCIAL VEHICLE OPERATIONS (CVO) (04 Hours)**

Emergency vehicle notification systems, Automatic road enforcement, Variable speed limits, Collision avoidance systems, Dynamic Traffic Light Sequence, Cooperative systems on the road, Automatic number plate recognition by Image processing, Impacts of CVO.

- **ITS APPLICATIONS (05 Hours)**

Advanced Traffic Management Systems (ATMS) Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS), Automated Highway Systems, and Framework for evaluating ITS related strategies.

- **ITS PROGRAMS IN THE WORLD (05 Hours)**

Overview of ITS implementations in developed countries, ITS in developing countries, Potential applications of offline and online real time measurement of traffic flow characteristics.

- **INTELLIGENT SUPPORTING TECHNOLOGIES (18 Hours)**

Wireless communications, Standards and Cellular Technology, ITS Data acquisition and processing, Hardware and Software--Micro-Controllers, PLC, Embedded systems, Ubiquitous Computing, Sensing Technologies,

Detectors/Detection Techniques— Triangulation Technique, Inductive loop detection, Video vehicle detection, Microwave detection, etc. Global Positioning System (GPS).

(Total contact hours:45)

Mapping of COs and POs

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

Mapping of COs and PSOs

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

Note: 1: Slightly 2: Moderately 3: Substantially

REFERENCES:

1. AUSTROADS, The Implication of Intelligent Transport Systems for Road Safety, Austroads Incorporated, 1999.
2. Bob Williams, Intelligent Transport Systems Standards, Artech House Publishers, 2008.
3. Sumit Ghosh and Tony Lee, Intelligent Transportation Systems, CRC Press, ISBN: 0849300673.
4. Chris Drane and C. R. Drane, Positioning Systems in Intelligent Transportation Systems, Artech House Publishers, ISBN: 0890065365.
5. Judy Mc Queen and Bob Mc Queen, Intelligent Transportation System and Architecture, Artech House Publishers, ISBN: 089006525X
6. Asad J. Khattak , Intelligent Transportation Systems: Planning, Operations, and Evaluation, CRC Press
7. Chowdhary M A and A Sadek. Fundamentals of Intelligent Transportation systems planning. Artech House Inc., US, 2003.
8. M.A. Chowdhury and A. Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House, 2010.
9. R P Roess, S E Prassas, and W R McShane. Traffic Engineering. Pearson Education International, 2005.
10. Yokota Toshiyuki and Weiland Richard. Its standards for developing countries. (3), 2004.
11. Stough, R. Intelligent Transport Systems: Cases and Policies, Edward Elgar, 2001, Artificial Intelligence and Intelligent Transportation Systems, National Academy Press, 2010.
12. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
13. Sussman, J. M., Perspective on ITS, Artech House Publishers, 2005.

National ITS Architecture Documentation, US Department of Transportation, 2007 (CDROM).

CE388 Smart Cities Planning and 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	Explain concept and global practices.
CO2	Study performance benchmarks, practice codes and national mission.
CO3	Design Smart Cities and draft relevant project management schemes.
CO4	Explain phases of Implementation and monitoring.
CO5	Explain phases of Finance and Governance.

2. Syllabus

- **INTRODUCTION** **(04 Hours)**
  Concept and practice of Smart Cities across the world, Purpose and importance of Smart Cities, Role of different stake-holders.

- **FRAMEWORK** **(10 Hours)**
  Human framework, Institutional framework, Energy framework, Data Management framework and technology framework, Present practice of road map for planning and benchmarking their performance for Indian context, accelerate impact, scaling up and across

- **PLANNING AND MANAGEMENT** **(16 Hours)**
  Planning and management for area-based development, PAN city solutions and retrofitting of existing area, greenfield development, integrated planning approach

- **SMART SOLUTIONS** **(11 Hours)**
  ICT in Smart City, Smart monitoring, Technology, Challenges, solutions and work around, replication and upscaling, Smart Infrastructure for building, mobility, energy, water and solid waste

- **FINANCE AND GOVERNANCE** **(04 Hours)**
  E-finance, E-governance, balancing top-down and bottom-up approach

(Total Lectures 45 hours , Tutorials : 15 hours)

3. Books Recommended

1. J Borsboom-van Beurden, Smart City Guidance Package for Integrated Planning and Management, NTNU, 2017.
2. Ministry of Urban Development Government of India, Smart Cities: Mission Statement & Guidelines, 2015.
3. T M V Kumar, E-Democracy for Smart Cities, Springer Nature, Singapore, 2019.
4. T M V Kumar, Smart Metropolitan Regional Development: Economic and Spatial Design Strategies, Springer Nature, Singapore, 2019.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	03	02	01	01	02	01	03	01	01	01	02	03
CO2	02	03	02	02	01	02	02	02	01	02	01	02
CO3	02	01	03	03	01	01	03	02	03	01	02	01
CO4	01	02	02	02	01	03	01	01	02	02	01	01
CO5	01	01	01	01	02	01	02	01	01	01	02	01

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

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	03	03	02
CO2	03	02	02
CO3	02	03	02
CO4	02	02	02
CO5	01	03	02

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

CE 392 Climate Change Studies

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 basics of weather, climate, climate variability, climate change and its impact
CO2	Describe various layers of atmosphere, heat balance of earth atmosphere system, variation of temperature and soil temperature, thermal time and thermal extremes and carbon cycle
CO3	Elaborate the extreme climate events and modelling of climate change
CO4	Apply statistical methods in hydro-climatology
CO5	Understand basics of weather, climate, climate variability, climate change and its impact

2. Syllabus

- **INTRODUCTION (04 Hours)**
  Hydrological cycle – Greenhouse effect – Weather – Climate – Climate variability – ENSO – IOD and climate change – Impacts of climate change – Sources of data for climate studies

- **FUNDAMENTALS OF CLIMATE CHANGE STUDY (10 Hours)**
  Overview of earth's atmosphere – Layers of atmosphere – Temperature – radiation and variation – Heat-balance of earth atmosphere system – Temporal variation of air temperature – Temperature change in soil – Thermal time and temperature extremes – Carbon cycle – Urban heat island.

- **EXTREME CLIMATE EVENTS (05 Hours)**
  Floods – Cloud burst – Droughts and Drought indicators – Heat waves – Sea level Rise – Compound Extremes.

- **CLIMATE CHANGE (06 Hours)**
  Introduction – Causes of climate change – Modelling of climate change – General circulation models – RCM – IPCC scenarios.

- **STATISTICAL METHODS IN HYDRO-CLIMATOLOGY (08 Hours)**
  Trend analysis – Empirical orthogonal functions – Principal component analysis – Canonical correlation – Statistical downscaling.

- **IMPACT AND MITIGATION MEASURES (12 Hours)**
  Regional Information on climate Change – observed impacts from climate change – vulnerability and exposure of ecosystems and people – risk in near term (2021-2040) – mid to long term risks (2041-2100) – complex – compound and cascading risks and impacts of temporary overshoot – Mitigation and development pathways in near to mid-term – long term mitigation pathways – mitigation potential across sectors and systems – societal aspects of mitigation and mitigation in the context of sustainable development.

(Total Lectures: 45 hours)

3. Books Recommended

1. G B Bonan, Ecological Climatology: Concepts and Applications, Cambridge University Press, 2008.
2. H V Storch and F W Zweirs, Statistical Analysis in Climatic Research, Cambridge, 1999.
3. P P Mujumdar and D N Kumar, Floods in Changing Climate, Cambridge university press, 2012 (First Edition).
4. K McGuffie and Henderson-Sellers, A Climate Modeling Primer, Wiley, 2005 (Third Edition).
5. IPCC, Sixth Assessment Reports, Intergovernmental Panel on Climate Change, Geneva, 2022.

4. Mapping of COs and POs

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

1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

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

1-Low 2-Moderate 3-High

CE 394
Water Infrastructure in Smart Cities

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 Water Distribution Network
CO2	Design Storm Water Network
CO3	Design Sewerage and Effluent Collection Network
CO4	Apply the integrated flood management practices
CO5	Apply the smart water technologies and resolve the conflicts.

2. Syllabus

- **URBAN WATER ISSUES**

(03 Hours) Water requirement, water availability, water budget, water balance, Zero liquid discharge concept and implementation

- **WATER DISTRIBUTION NETWORK** **(08 Hours)**
  Life cycle cost of distribution network, design and analysis of water distribution network.

- **SEWERAGE AND EFFLUENT COLLECTION NETWORK** **(09 Hours)**
  Design of sewerage network, Design of effluent collection network

- **STORM WATER NETWORK AND INTEGRATED FLOOD MANAGEMENT** **(09 Hours)**

Selection of IDF, Design of Storm water network with innovation, Flood plain delineation, integrated flood
management practice

- **SMART WATER MANAGEMENT TECHNOLOGIES** **(08 Hours)**
  Human-machine interface, wireless sensors, remote monitoring solution, SCADA

- **CONFLICTS IN WATER RELATED INFRASTRUCTURE AND ITS SOLUTIONS** **(07 Hours)**

Priority of water related infrastructure, conflicts, resolution of conflicts based on hydraulics of flow

[Total Hours: 45 Hours, Tutorial: 15 hours]

3. Books Recommended

1. Ronald L. Rossmilller, Storm water design for sustainable development, Mc.Graw-Hill Education, USA ISBN: 978-0-07-181652-6.
2. P R Bhave and R Gupta, Analysis of Water Distribution Networks, Narosa Publishing House Pvt. Ltd.,
New Delhi, ISBN-123:978-81-7319-778-9.
3. L W Mays, Water Resources Engineering (second ed.), John Wiley and Sons., New Jersey, USA

ISBN::
978-0-470-46064-1.
4. Central Public Health and Environmental Engineering Organization (CPHEEO), Manual on Sewerage and
Sewage Treatment Part A: Engineering, MoUD, New Delhi, 2002.
5. Central Public Health and Environmental Engineering Organization (CPHEEO), Manual on Water Supply and Treatment, MoUD, New Delhi, 2008.

4. Mapping of COs and POs

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

1-Low 2-Moderate 3-High

5. Mapping of COs and PSOs

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

1-Low 2-Moderate 3-High