REVISED CURRICULUM FOR B.TECH.

(Civil Engineering)

PROGRAMME

(w.e.f. AY 2022-23)

Model – 1

(For Batch 2020-23)

Department of Civil Engineering

SVNIT, Surat

Department of Civil Engineering

B.Tech. Civil Engineering: New Teaching Scheme
Batch (A.Y. 2020-21 to A.Y. 2023-24)

[There is no change in scheme of first and second year]

Summary of Teaching Scheme			
Year	**Semester**	**Credits**	**Hours per week**
1	1 & 2	49	-
2	3	23	26
	4	24	29
3	5	26	31
	6	25	28
4	7	23	29
	8	10	40
Grand Total		**180**	

SEMESTER – III

(Effective for A.Y. 2021-22)

Sr. No.	Course	Code	Scheme	Exam Scheme				Total	Credit
				Theory		Tuto.	Pract.		
				Hours	Marks	Marks	Marks		
1.	Engineering Mathematics - III	MA215	3-1-0	3	100	25	0	125	04
2.	Hydraulic Engineering	CE201	4-1-2	4	100	25	50	175	06
3.	Basic Transportation Engineering	CE203	3-1-0	3	100	25	0	125	04
4.	Mechanics of Solids	CE205	3-1-2	3	100	25	50	175	05
5.	Geotechnical Engineering	CE207	3-0-2	3	100	0	50	150	04
		Total	**16-4-6**	**16**	**500**	**100**	**150**	**750**	**23**
	Total Teaching Hours		**26**						

Minor Course: CE207 Geotechnical Engineering

SEMESTER – IV

(Effective for A.Y. 2021-22)

Sr. No.	Course	Code	Scheme	Exam Scheme				Total	Credit
				Theory		Tuto.	Pract.		
				Hours	Marks	Marks	Marks		
1.	Environmental Engineering, I	CE202	3-1-2	3	100	25	50	175	05
2.	Concrete Technology	CE204	3-0-2	3	100	0	50	150	04
3.	Structural Analysis I	CE206	3-0-2	3	100	0	50	150	04
4.	Geomatic Surveying	CE208	3-1-2	3	100	25	50	175	05
5.	Building and Town Planning	CE212	4-1-2	4	100	25	50	175	06
		Total	**16-3-10**	**16**	**500**	**75**	**250**	**825**	**24**
	Total Teaching Hours		**29**						

Minor Courses: CE204 Concrete Technology

SEMESTER – V

(Effective for A.Y. 2022-23)

Sr No	Course	Code	Scheme	Exam Scheme				Total	Credit
				Theory		Tuto.	Pract.		
				Hours	Marks	Marks	Marks		
1.	Professional Ethics, Economics and Business Management	HU301	3-1-0	4	100	25	0	125	04
2.	Estimation and Cost Analysis	CE301	3-1-2	3	100	25	50	175	05
3.	Environmental Engineering II	CE303	3-1-2	3	100	25	75	150	05
4.	Core Elective 1	CE3AA	3-0-0	3	100	0	0	100	03
5.	Institute Elective-1	CE3XX	3-0-0	3	100	0	0	100	03
6.	Seminar	CE305	0-0-2	0	0	0	50	50	01
7.	Structural Analysis II	CE302	3-1-2	3	100	25	50	175	05
		Total	**18-4-8**	**19**	**600**	**75**	**200**	**875**	**26**
	Total Teaching Hours		**30**						

Minor Course: CE 301: Estimation and Cost Analysis

Core Electives-1

Sr. No.	Core Elective-1 (5th Semester) CE3AA
1.	CE 321 Advanced Geotechnical Engineering
2.	CE 323 Engineering Geology

Institute Electives-1

Sr. No.	Institute Elective-1 (5th Semester) CE3XX
1.	CE 361 Industrial safety and Environment
2.	CE 363 Environmental Management
3.	CE 367 Rural Planning and Management
4.	CE 369 Transportation Safety and Environment
5.	CE 371 Fundamentals of GIS and Remote Sensing
6.	CE 373 Building Information Modelling
7.	CE375 Mechanics of Solids
8.	CE 377 Introduction to Earthquake Engineering
9.	CE 379 Introduction to Structural Engineering
10.	CE 381 Rehabilitation and Strengthening of Structures

SEMESTER – VI

(Effective for A.Y. 2022-23)

Sr. No.	Course	Code	Scheme	Exam Scheme				Total	Credit
				Theory		Tuto.	Pract.		
				Hours	Marks	Marks	Marks		
1.	Innovation, Incubation and Entrepreneurship	HU410	3-0-0	3	100	0	0	100	03
2.	Highway Engineering	CE304	3-1-2	3	100	0	50	150	05
3.	Water Resources Engineering	CE306	4-1-2	4	100	25	50	`175	06
4.	Design of Steel Structures	CE308	3-1-2	3	100	25	50	175	05
5.	Core Elective 2	CE3BB	3-0-0	3	100	0	0	100	03
6.	Institute Elective-2	CE3YY	3-0-0	3	100	0	0	100	03
		Total	**19-3-6**	**19**	**600**	**50**	**150**	**800**	**25**
	Total Teaching Hours		**28**						

Minor Courses: CE 304 Highway Engineering

CE 306 Water Resources Engineering

Core Electives-2

Sr. No.	Core Elective-2 (6th Semester) CE3BB
1.	CE322 Sustainable Building Planning
2.	CE324 Housing
3.	CE326 Pavement Analysis and Design
4.	CE328 Transport Economics
5.	CE332 Ground water hydrology
6.	CE334 Channel Hydraulics
7.	CE336 Advanced Surveying
8.	CE338 Environmental Ethics Law and Policy
9.	CE342 Construction Safety Management

Institute Electives-2

Sr. No.	Institute Elective-2 (6th Semester) CE3YY
1.	CE362 Environment Health and Risk Management
2.	CE364 Air Pollution and Control
3.	CE366 Smart Cities Planning and Management
4.	CE368 Climate change studies
5.	CE372 Intelligent Transport System
6.	CE374 Water Infrastructure in Smart cities
7.	CE 376 Waste to Energy Technologies
8.	CE 378 Disaster Management
9.	CE 382 Advanced Mechanics of Solids

SEMESTER – VII

(Effective for A.Y. 2023-24)

Sr. No.	Course	Code	Scheme	Exam Scheme				Total	Credit
				Theory		Tuto.	Pract.		
				Hours	Marks	Marks	Marks		
1.	Heavy Construction and Project Management	CE401	3-1-0	3	100	25	0	125	04
2.	Design of Concrete Structures	CE403	3-1-2	3	100	25	50	175	05
3.	Core Elective-3	CE4AA	3-0-0	3	100	0	0	100	03
4.	Core Elective-4	CE4BB	3-0-0	3	100	0	0	100	03
5.	Core Elective-5	CE4XX	3-0-0	3	100	0	0	100	03
6.	Project	CE407	0-0-10	0	0	0	150	150	05
		Total	**15-2-12**	**15**	**500**	**50**	**200**	**750**	**23**
	Total Teaching Hours		**29**						

Core Electives-3

Sr. No.	Core Elective-3 (7th Semester) CE4AA	Core Elective-4 (7th Semester) CE4BB
1.	CE421 Urban Infrastructure Planning and Management	CE 447 Design of Industrial Structures
2.	CE423 Urban Land Management	CE 449 Ground Engineering
3.	CE425 Urban Transport Systems Planning	CE 451 Advanced Concrete Technology
4.	CE427 Flood control and River Training works	CE 453 Geo-synthetic and Reinforced Soil Structure
5.	CE429Advanced Hydrologic Analysis & Design	CE 455 Introduction to Finite Element Methods
6.	CE431 Advanced Fluid Mechanics	CE 457 Rock Mechanics
7.	CE433 Stochastic Hydrology	CE459 Design of Formwork
8.	CE435 GPS and Applications	-
9.	CE437 Industrial Waste Management	-
10.	CE439 Building Maintenance	-
11.	CE441 Environmental Health and Risk Management	-
12.	CE443 Air Pollution and Control	-
13.	CE445 Traffic Engineering and Management	-

Core Electives-5

Sr. No.	Core Elective–5 (7th Semester)CE4XX
1.	CE422 Regional Planning
2.	CE424 Real Estate management
3.	CE426 Urban Design and Landscape Planning
4.	CE428 Tourism Planning and Development
5.	CE432 Smart Cities Planning and Management
6.	CE434 Public Transport Systems and Operations
7.	CE436 Transportation Safety and Environment
8.	CE438 Waterways Infrastructure Planning & Design
9.	CE442 Traffic Flow Theory
10.	CE444 Advanced Hydraulics Structure
11.	CE446 Hydraulics of Alluvial Rivers
12.	CE448 Computational Hydraulics
13.	CE452 Geospatial Techniques
14.	CE454 Advanced Water and Wastewater Treatment
15.	CE456 Solid and Hazardous Waste Management
16.	CE458 Metro Construction Technology
17.	CE462 Environmental Impact Assessment
18.	CE464 Construction Laws
19.	CE466 Professional Practice
20.	CE468 Advanced Construction Technology
21.	CE472 Operation and Maintenance Management of Pavements

SEMESTER – VIII

(Effective for A.Y. 2023-24)

Sr. No.	Course	Code	Scheme	Exam Scheme		Total	Credit
				Continuous Assessment	End Semester Assessment		
				(Marks)	(Marks)		
1.	Industrial Internship	CE 402	0-0-40*	160	240	400	10
	Grand Total						180

- **Students are expected to work at sites / organizations for 8 hours / day for 5 days/week**

Sardar Vallabhbhai National Institute of Technology Surat

Mission of Institute

To be a globally accepted centre of excellence in technical education catalysing absorption, innovation, diffusion and transfer of high technologies resulting in enhanced quality for all the stake holders

Vision of Institute

To be one of the leading Technical Institutes disseminating globally acceptable education, effective industrial training and relevant research output

About Department of Civil Engineering

The Civil Engineering Department came into existence in the year 1961. The Civil Engineering Department is one of the founding departments of the Institute. The department has grown tremendously over the years, especially after the conversion of the institute to an NIT, and is now one of the best Civil Engineering Departments among NITs in the country. The department has well qualified and dedicated faculty members with the specialization in various areas of Civil Engineering. The activities of the department are carried out under seven different sections namely Structural Engineering, Geotechnical Engineering, Environmental Engineering, Transportation Engineering and Planning, Urban Planning, Water Resources Engineering and Construction Technology and Management. The department is involved in UG & seven PG programmes and a research program leading to Ph.D. degree. Students of the department with their diversified culture/background are in the forefront of acquiring professional and technical knowledge. They conduct various technical and non-technical events under Civil Engineering Society. The students regularly receive many awards/fellowships from governmental and non-governmental agencies. The department has been a pioneer and leader to carry out testing and challenging consultancy work in the different areas of Civil Engineering.

Mission of the Department

- To provide excellent education producing technically competent, globally employable civil engineers who will be leaders in the chosen field.
- To undertake research in conventional and advanced technologies fulfilling the needs and challenges of modern society.
- To provide consultancy services and develop partnerships with society, industry and public organizations.
- To organize seminars, conferences, symposia, and continuing education programmes for academic and field communities.

Vision of the Department

- To be a global centre of excellence for creating competent professionals in Civil Engineering

Programme Educational Objectives (PEOs)

PEO 1 Have successful career in civil engineering field or in their chosen field.

PEO 2 Pursue life-long learning including higher education and research.

PEO 3 Serve society with professional ethics and integrity.

Programme Outcomes (POs)

PO 1 Apply knowledge of mathematics, sciences and engineering fundamentals to solve complex problems of Civil Engineering.

PO 2 Identify, formulate, research literature and analyse complex problems pertaining to Civil Engineering.

PO 3 Design solutions for complex Civil Engineering problems to meet the needs of the society with respect to sustainable development considerations.

PO 4 Design research experiments for acquisition/ generation, analysis and interpretation of data for Civil Engineering problems.

PO 5 Apply advanced tools, techniques and latest software to solve complex Civil Engineering problems.

PO 6 Shoulder responsibilities in context to societal, health, safety, legal & cultural issues consequent to Civil Engineering practices.

PO 7 Understand impact of infrastructure solutions on societal and environmental aspects in context of sustainable development.

PO 8 Apply ethical principles in Civil Engineering practices and professional responsibilities.

PO 9 Work independently or in a team as a member/ leader in multidisciplinary tasks.

PO 10 Communicate effectively and presentation with Civil Engineering professionals and society at large.

PO 11 Demonstrate knowledge of management principles and engineering techniques for effective project management.

PO 12 Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs)

PSO 1 Graduates will be competent to use comprehended knowledge in science, humanities, mathematics, and civil engineering to deal with various professional matters and provide cost-effective, environment-friendly and sustainable solutions.

PSO 2 Graduates will be proficient to plan, design, construct and manage any project as a team member or team leader ethically serving the society and the nation as a whole.

PSO 3 Graduates will be confident to undertake self-learning, identify complex issues of Civil Engineering and formulate research programmes to contribute towards infrastructure growth and development of the nation using multi-disciplinary approach and skills.

Prerequisites for B.Tech. Civil SVNIT

Sr No.	Course Code	Course Title	Prerequisites	Credit
1	CE 321	Advanced Geotechnical Engineering	CE 207 Geotechnical Engineering	03
2	CE 453	Geosynthetic and Reinforced Soil Structure	CE 321 Advanced Geotechnical Engineering	03
3	CE 496	Ground Improvement Techniques	CE 321 Advanced Geotechnical Engineering	03
4	CE401	Heavy Construction and Project Management	CECE-113S2 Building Technology CE-212 Building and Town Planning CE-301 Estimation and Cost Analysis	04
5	CE424	Real Estate Management	CECE-113S2 Building Technology CE-212 Building and Town Planning	03
6	CE205	Mechanics of Solids	AM108 Engineering Mechanics	05
7	CE206	Structural Analysis I	AM108 Engineering Mechanics CE205 Mechanics of Solids	04
8	CE302	Structural Analysis II	AM108 Engineering Mechanics CE205 Mechanics of Solids CE206 Structural Analysis I	05
9	CE304	Design of Steel Structures	AM108 Engineering Mechanics CE205 Mechanics of Solids CE206 Structural Analysis I	04
10	CE447	Design of Industrial Structures	CE304 Design of Steel Structures CE206 Structural Analysis I CE302 Structural Analysis II	03
11	CE403	Design of Concrete Structures	AM108 Engineering Mechanics CE205 Mechanics of Solid	04

			CE206 Structural Analysis I CE204 Concrete Technology CE302 Structural Analysis II	
12	CE474	Advanced Design of Concrete Structures	AM108 Engineering Mechanics CE 205 Mechanics of Solids CE206 Structural Analysis I CE302 Structural Analysis II CE204 Concrete Technology CE403 Design of Concrete Structures	03
13	CE476	Design of Prestressed Concrete Structures	CE206 Structural Analysis I CE302 Structural Analysis II CE204 Concrete Technology CE474 Design of Concrete Structures	03
14	CE478	Design of Bridge Structures	CE304 Design of steel structure CE474 Design of concrete structures	03
15	CE484	Computer Aided Design of Structures	CE206 Structural Analysis I CE302 Structural Analysis II CE474 Design of Concrete Structures CS109 Computer Fundamentals and Programming	03

SEMESTER III

MA 215 Engineering Mathematics III

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 concept of convergence and divergence of infinite series
CO2	Develop the Fourier series of the periodic functions
CO3	Derive Fourier integral from Fourier series and comprehend the concept of integral transforms with their applications.
CO4	Analyse the partial differential equations of second order.
CO5	Apply fundamentals of probability and statistics in engineering problem solving

2. Syllabus

- **INFINITE SERIES** **(06 Hours)**
  Introduction, Positive term series, Comparison test, Cauchy's root test, D'Alembert's test, Raabe's test, Logarithmic test, Integral test, Gauss's test, Series with arbitrary terms, Rearrangement of terms.

- **FOURIER SERIES** **(06 Hours)**
  Definition, Fourier series with arbitrary period, in particular periodic function with period 2π. Fourier series of even and odd function, Half range Fourier series.

- **FOURIER INTEGRAL AND FOURIER TRANSFORMS** **(07 Hours)**
  Fourier Integral theorem, Fourier sine and cosine integral complex form of integral, Inversion formula for Fourier transforms, Fourier transforms of the derivative of a function.

- **LAPLACE TRANSFORMS** **(07 Hours)**
  Introduction, Definition, Existence conditions, basic properties, Inverse Laplace transform and properties, Convolution Theorem and properties, Applications of Laplace transforms.

- **PARTIAL DIFFERENTIAL EQUATION** **(08 Hours)**
  Second order PDE of Mathematical Physics (Heat, wave and Laplace equation, one dimensional with standard boundary conditions, solution by separation of variable method using Fourier series, Solution by Separation of variables and transformation techniques.

- **STATISTICS** **(08 Hours)**

  Correlation between two variables, application of correlation, evaluation of coefficients of correlation, Rank correlation, Regression, frequency distribution, Binomial, Poisson's distribution and Normal distribution, application to industrial problem. Test of significance, Chi-square)$\chi 2$ test, student's t- test, application of the t-test, F-distribution

(Total Lectures: 42 hours, Tutorials: 14 hours)

3. Books Recommended

1. E Kreyszig, Advanced Engineering Mathematics, John Wiley, New Jersey. 1995.
2. C R Wiley, Advanced Engineering Mathematics, McGraw-Hill, New York, 1993.
3. Peter O'Niel, Advanced Engineering Mathematics, Thompson, Singapore, 2002.
4. M D Greenberg, Advanced Engineering Mathematics, Pearson, Singapore, 2007.
5. B V Ramana, Higher Engineering Mathematics, The MaGraw-Hill Inc., New Delhi, 2007.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 201 Hydraulic Engineering

L	T	P	C
4	1	2	6

1. Course Outcomes (COs)

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

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

2. Syllabus

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

- **FLUID KINEMATICS AND DYNAMICS** **(10 Hours)**
  Concept of fluid particles, stream lines, path lines, differential forms of continuity equation, stream function, translation, deformation, rotation, circulation and vorticity of fluid elements, stream function, potential function, flow net, acceleration of fluid elements; System and control volume including Reynolds transport theorem. Steady linear momentum equation, Euler's equation for one-dimensional flow, Bernoulli's equation including its applications for fluid
  flow problems.

- **BOUNDARY LAYER THEORY** **(05 Hours)**
  Theory Concept and thickness of laminar and turbulent boundary layers over flat plates, application of integral momentum equation, boundary layer separation and their control, concept of drag and lift including streamlined bodies.

- **LAMINAR AND TURBULENT FLOWS** **(08 Hours)**
  Reynolds experiments, Reynolds number and classification of laminar, transition and turbulent flows, flow development in laminar and turbulent flows, shear stress distribution, HagenPoiseuille's equation, Coquette flow; characteristics of turbulent flows, Reynolds

shear stresses, Prandtl's mixing length theory, velocity distributions in closed conduit flows with hydro dynamically smooth and turbulent flows, friction factor.

- **APPLICATION OF FLUID FLOWS THROUGH PIPES** **(05 Hours)**
  Major and minor head losses, pipes in series and parallel, pipes with equivalent diameter and length, Total energy and hydraulic gradient lines, Two and three reservoir problems, analysis of water distribution network.

- **DIMENSIONAL ANALYSIS** **(04 Hours)**
  Development of functional relationships for fluid flows, pertinent and superfluous variables, Physical model laws, scale effect, distorted and undistorted models.

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

- **HYDRAULIC MACHINES** **(08 Hours)**
  Impact of jet on stationary and moving flat and curved vanes, working principles and design aspects of Pelton, Francis and Kaplan Turbines, unit quantities, specific speed, Characteristics of turbines, classification of pumps, working principles and components of pumps, velocity vector diagram and work done by pumps.

(Total Lectures: 56 hours, Tutorial: 14 hours)

3. Practical

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

4. Books Recommended

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

5. Mapping of COs and POs

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

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

6. Mapping of COs and PSOs

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

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

CE 203 Basic Transportation 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	Explain the basic modes of transportation and their importance in selecting the effective transportation mode considering the socio-economical and geographical aspects.
CO2	Analyse the various parameters including surveys for planning of new transportation systems (Railway, Waterway and Airways).
CO3	Identify the forces and stresses to be considered while designing various transportation structures like railway track, harbour components, runway, bridge and tunnels.
CO4	Design the layout pf terminal facilities like railway stations, yards for railways, docks and harbours for waterways and airport for airways.
CO5	Design the layout of terminal facilities like railway stations, yards for railways, docks and harbours for waterways and airport for airways.

2. Syllabus

- **INTRODUCTION TOTRANSPORTATION SYSTEMS (02 Hours)**
  Transport Systems - Introduction, development of road transport, air transport, waterways, Comparison of various modes of transportation.

- **RAILWAYS (14 Hours)**
  Permanent Way - Preliminary survey, reconnaissance survey, location survey, development, gauges, uniformity of gauges, types and functions of various components such as rails, sleepers, ballast, rail, fastening etc., coning of wheels, gradient and grade compensation, Track Modulus and Track Design, various stresses Points and Crossings - Terminology, various types of track junctions, turnout and diamond crossing, Construction and Maintenance - Plants and laying, material requirements, construction methods, Stations and yards.

- **TRANSPORTATIONSTRUCTURES (08 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, loads and stresses.

- **DOCKS AND HARBOURS (08 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.

- **AIR TRANSPORT** **(10 Hours)**
  Airport planning, Surveys for site selection, Wind rose diagram and its utility, Runway Design, Taxiway, Apron, Hanger, Radar, Planning of terminal area of airport, Classification of airports, Instrument Landing System, Air Traffic Control, Design of Air field Pavement, Pavement Classification Number. Various bodies and their role in air transportation: ICAO, FAA, AAI.

(Total Lectures: 42 hours, Tutorials: 14 hours)

3. Books Recommended

1. V N Vazirani and C D Chandola, Transportation Engineering – Vol. I to IV, Khanna Publishers, New Delhi, 1999.
2. R Horenjeff, Planning and Design of Airports McGraw Hill Book Co., NewDelhi, 1985.
3. S C Saxena and K L Arora, Railway Engineering, Dhanpat Rai and Sons, New Delhi, 1995
4. S P Bindra, Bridge Engineering, Dhanpat Rai and Sons, New Delhi, 1997.
5. S Chandra and M M Agarwal, Railway Engineering, Second Edition, Oxford University Press, New Delhi, 2013

4. Mapping of COs and POs

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

-0 Not related 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	1	1	1

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

CE 205 Mechanics of Solids

3	1	2	5

1 Course Outcomes (COs)

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

CO1	Apply the knowledge of mechanical/elastic/thermal properties of materials and constitutive relationships to solve elementary level determinate and indeterminate problems.
CO2	Analyze the response of structural elements subjected to axial force, bending, shear and torsion or in combination and graphically represent the distribution.
CO3	Evaluate strain energy and principal stresses-strains for subsequent applications of failure theories.
CO4	Design and analyze columns, springs, thin cylinders and spherical shells.
CO5	Evaluate strain energy and principal stresses-strains for subsequent applications of failure theories

2. Syllabus

- **STRESSES AND STRAINS (06 Hours)**
  Concept of stresses and strains – Types of stresses – Hook’s Law – Lateral strain – Poisson’s ratio – Elongation due to own weight – Tapering sections – Varying cross sections – Composite sections – Relation between Modulus of Elasticity, Modulus of Rigidity and Bulk Modulus – Thermal Stresses – Eccentric load – Limit of eccentricity – Core /Kernel of the section.

- **SHEAR FORCE DIAGRAM AND BENDING MOMENT DIAGRAM (05 Hours)**
  Types of beams – Types of supports – Types of loads – shear force – Bending moment – Sign conventions – Overhanging beams – Point of contra-flexure – Varying loads – Relation between SF and BM.

- **STRESSES IN BEAMS (04 Hours)**
  Theory of simple bending – Moment of Resistance – Beam of Uniform strength – Flitched beams – Shear stress concept – Derivation of shear stress – Shear stress variation in rectangular, circular, T-section and I – section

- **TORSION (04 Hours)**
  Basic theory of Torsion – Solid shaft – Hollow shaft – Power transmitted by shaft – Composite shafts

- **STRAIN ENERGY (04 Hours)**

Strain energy – Resilience – Strain energy due to Tension and compression - Strain energy due to freely falling load

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

- **THEORIES OF FAILURE** **(03 Hours)**
  Strain energy – Resilience – Strain energy due to Tension and compression - Strain energy due to freely falling load.

- **COLUMN AND STRUTS** **(04 Hours)**
  Euler's theory for columns – Different end conditions – Rankine's formula – Limitations of Euler's theory. Direct and bending stresses in columns. Limit of eccentricity.

- **SPRINGS** **(04 Hours)**
  Types of springs – Close coiled helical spring subjected to axial load and twist – Leaf springs – Semi elliptical and Quarter elliptical leaf springs

- **THIN CYLINDERS** **(04 Hours)**
  Stresses in cylinders – Thin cylinders and thin spheres – Volumetric strain – Wire wound thin cylinders

(Total Lectures: 42 hours, Tutorial: 14 hours)

3. Practical

1. To determine the elasticity and various stresses for mild steel and cast-iron specimens conducting tension test.
2. To determine the various stresses and modulus of rigidity for mild steel specimen conducting torsion test.
3. To determine the toughness of various materials using Charpy impact test
4. To determine the flexural strength and elasticity of wooden beam conducting transverse test.
5. To determine the compressive strength of cast iron column conducting compression test.
6. To determine the shear strength of mild steel and aluminium.
7. To determine the shear strength of mortar
8. To determine the shear strength of concrete specimen.
9. To determine the shear strength of timber specimen.
10. To determine the hardness of metal conducting hardness test.

4. Books Recommended

1. S Timoshenko and D H Young, Elements of Strength of Materials, Tata McGraw Hill, New Delhi, 2006.
2. G H Ryder, Strength of Materials, English Language Book Society, New Delhi, 2006.

3. S S Bhavikatti, Strength of Materials, Vikas Publication House, New Delhi, 2007.
4. P Egar. Popov and T A Balan, Engineering Mechanics of Solids, 2nd Edition, Pretice Hall of India Pvt Ltd, New Delhi, 2002.
5. F. P. Beer and Johnston S J, Strength of Materials, Tata McGraw Hill, New Delhi, 2004.

5. Mapping of COs and POs

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

-0 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

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

CE 207 Geotechnical Engineering

L	T	P	C
3	0	2	4

1. Course Outcomes (COs)

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

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

2. Syllabus

- **INTRODUCTION** **(03 Hours)**
  Need for Soil Engineering Studies - Soil as an Engineering Material -Scope of Geotechnical Engineering, Introduction to Engineering.

- **BASIC PROPERTIES OF SOIL** **(05 Hours)**
  Elementary properties and their measurements - Constituents of soil - Phase diagram – Definitions of varies parameters and their Interrelationship – In-situ determination of density.

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

- **COMPACTION** **(04 Hours)**
  Definition - objectives - Laboratory tests- Zero air void Line -Factors affecting compaction-Effect of compaction on properties of soil - Field compaction control - Relative compaction.

- **PERMEABILITY AND SEEPAGE** **(05 Hours)**
  Permeability - Darcy’s law - Laboratory tests - Field tests - Permeability of stratified deposits– Laplace’s equation - Seepage - Flow net.

- **EFFECTIVE STRESS ANALYSIS** **(04 Hours)**
  Effective stress principle- Effect of water table fluctuation on effective stress-Effective stress in soil mass due to hydrostatic conditions, capillary action and steady seepage conditions-Effect of surcharge on effective stress-Quick sand condition.

- **CONSOLIDATION** **(05 Hours)**
  Significance of Consolidation - Initial, primary and secondary consolidation - Spring analogy for primary consolidation- Consolidation test- Various parameters - Terzaghi's theory of one dimensional consolidation - Coefficient of consolidation – Preconsolidation pressure – Secondary consolidation-Field consolidation curve.

- **SHEAR STRENGTH** **(05 Hours)**
  Shear parameters –Mohr-Coulomb's Failure Criterion – Various laboratory tests and their merits and demerits - Drainage conditions- Modified failure envelop– Pore Pressure Parameters.

- **SOIL EXPLORATION AND BEARING CAPACITY** **(04 Hours)**
  Types of springs – Close coiled helical spring subjected to axial load and twist – Leaf springs – Semi elliptical and Quarter elliptical leaf springs

- **THIN CYLINDERS** **(04 Hours)**
  Objectives and methods of explorations-Sampling and its design features, SPT, Cone penetration test and in-situ vane shear test, Bearing Capacity.

(Total Lectures: 42 hours)

3. Practical

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

4. Books Recommended

1. K R Arora, Soil Mechanics and Foundation Engineering (Geotechnical Engineering), Standard Publishers Distributors, Delhi, 2008.

2. K Terzaghi, R B Peck, G Mesri, Soil Mechanics in Engineering Practice, John Wiley and Sons, New Jersey, 1996.
3. J E Bowles, Foundation Analysis and Design, McGraw-Hill, New Delhi, 1996.
4. B M Das, K Sobhan, Principles of Geotechnical Engineering, Cengage Learning, Boston, 2018.
5. D P Coduto, M R Yeung, W A Kitch, Geotechnical Engineering: Principles and Practices, 2nd Ed, Pearson Education, Singapore, 2017

5. Mapping of COs and POs

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

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

6. Mapping of COs and PSOs

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

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

SEMESTER IV

CE 202 Environmental Engineering I

L	T	P	C
3	1	2	5

1. Course Outcomes (COs)

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

CO1	Analyze water quality and quantity requirements for given uses
CO2	Design water treatment plant based on the source water quality
CO3	Design simple water distribution networks
CO4	Analyse rural water supply demand and treatment methods
CO5	Explain air pollutants, their effects and control strategies

2. Syllabus

- **QUALITY AND QUANTITY OF WATER** **(10 Hours)**
  Water quality parameters – physical, chemical and microbiological , principles of their analysis. Drinking water quality standards. Water demand – types of demand, variation in demand, population forecast. Sources of water - Intake structures

- **WATER TREATMENT** **(15 Hours)**
  Need for water treatment. Process details and design considerations of treatment units such as aeration, sedimentation, coagulation and flocculation, filtration, disinfection, and water softening. Introduction to advanced water treatment methods such as adsorption, ion exchange and reverse osmosis.

- **WATER DISTRIBUTION SYSTEMS** **(05 Hours)**
  Pumps and pumping stations. Pipes, Pipe appurtenances. Testing of water main - Distribution reservoirs - Distribution methods – Introduction to pipe network analysis - Planning of water supply project.

- **RURAL WATER SUPPLY AND TREATMENT** **(02 Hours)**
  Water demand and treatment techniques for rural areas, protected water supplies. Packaged treatment plants. Household water treatment methods.

- **AIR POLLUTION AND CONTROL** **(10 Hours)**
  Air pollution sources and effects. Meteorology, Control of gaseous and particulate air pollutants, Noise pollution and control.

(Total Lectures: 42 hours, Tutorials: 14 hours)

3. **Practical**

1. Determination of Turbidity.
2. Determination of Chloride.
3. Determination of Hardness.
4. Determination of pH, Carbonate, Bicarbonate and Hydroxide Alkalinity.
5. Determination of Chlorine Demand and Chlorine Residual.
6. Determination of Fluorides
7. Determination of optimum coagulant dosage
8. Bacteriological Analysis of water.
9. Demonstration of air pollution monitoring equipment.
10. Demonstration of noise level meter.

4. **Books Recommended**

1. M L Davis, Water and Wastewater Engineering, McGraw-Hill, New Delhi, 2010.
2. Manual on Water Supply and Treatment 3rd Ed. Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1999.
3. R L Droste, Theory and Practice of Water and Wastewater Treatment, John Wiley and Sons, New York, 1997.
4. T J McGhee, Water Supply and Sewerage, McGraw-Hill, New Delhi, 1991.
5. B C Punmia, A Jain and A Jain, Water Supply Engineering, Laxmi Publications, New Delhi, 2015.

5. **Mapping of COs and POs**

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

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

6. **Mapping of COs and PSOs**

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

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

L	T	P	C

CE 204 Concrete Technology

3	0	2	4

1. Course Outcomes (COs)

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

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

2. Syllabus

- **STRESSES AND STRAINS** **(06 Hours)**
  Manufacturing of Portland cement - Chemical composition of Portland cement - Hydration of cement and action of gypsum - Setting of cement - Physical and chemical test for cement as per IS:4031, IS:269 - Different types of cement - Chemical composition - Important properties and applications - Admixtures – Accelerators - Retarder water reducing agents – Plasticizers - Water proofing compounds - Pumping aids.

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

- **FRESH CONCRETE** **(06 Hours)**
  Definition of workability, factors affecting workability - Measurement of workability - Slump test, compacting factor test -, Segregation and blending of concrete - Mixing of concrete - Types of mixtures - Vibration of concrete - Types of vibrators - Internal external surface and table vibrators - Concreting in hot and cold weather - Ready mixed concrete - Pumped concrete - Pre placed aggregate concrete - Vacuum processed concrete - Shotcrete or Gunitting.

- **STRENGTH OF CONCRETE** **(06 Hours)**
  Factors affecting strength of concrete - Different methods of Curing and Steam Curing at Atmospheric Pressure and High-Pressure Curing - Warm water method.

- **TESTING OF HARDENED CONCRETE** **(06 Hours)**
  Need for testing, Compression test – Cube, cylinder - Prism and equivalent cube test - Effects of various factors on test results e.g. end conditions – Capping - Moisture content - Height/Diameter ratio - Shape of specimen - Rate of loading - Size of specimen - Comparison of strength of cubes and cylinders - Flexure test - Split tensile test - Non-destructive testing, needs and applications - Rebound hammer test – Ultrasonic Pulse Velocity test – Core test.

- **MIX DESIGN** **(06 Hours)**
  Definition and need for designing mixes - Methods of mix design - IS method of mix design in detail with examples.

- **SPECIAL CONCERTE** **(06 Hours)**
  Polymer Concrete - Fibre Reinforced Concrete - Light Weight Concrete - High Density Concrete - Use of Silica Fume and Metacaoline in Concrete - Fly ash Concrete .

(Total Lectures: 42 hours)

3. Practical

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

4. Books Recommended

1. A M Neville, Properties of Concrete, Pitman Publishing Company, Bath, U.K., 1973.
2. M S Shetty, Concrete Technology, Theory and Practice" 2nd ed., S. Chand and Company, New Delhi, 1986.
3. M L Gambhir, Concrete Technology, Tata McGraw Hill Company, New Delhi, 1986.
4. Shanthakumar, Concrete Technology, Tata McGraw Hill Company, New Delhi, 2006.
5. G E Troxell and H E Davis, Composition and Properties of Concrete, Mc Graw Hill Publication, 1998.

5. Mapping of COs and POs

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

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

6. Mapping of COs and PSOs

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

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

CE 206 Structural Analysis I

L	T	P	C
3	0	2	4

1. Course Outcomes (COs)

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

CO1	Explain unsymmetrical bending and shear centre
CO2	Apply the concepts of ILD and moving loads on determinate structures.
CO3	Analyse displacement of statically determinate trusses and beams.
CO4	Analyze statically determinate structures.
CO5	Analyze statically indeterminate structures.

2. Syllabus

- **BASIC INTRODUCTORY CONCEPTS** **(04 Hours)**
  Structural Systems – Degrees of Freedom - Determinate and indeterminate structures- Unsymmetrical bending – Shear centers for thin walled open sections.

- **ANALYSIS OF STATICALLY DETERMINATE STRUCTURES** **(05 Hours)**
  Analysis of Beams with internal hinges – Analysis of frames.

- **ANALYSIS OF SPACE TRUSSES** **(05 Hours)**
  Basic Principles – Types of support – Method of tension coefficient.

- **INFLUENCE LINES** **(05 Hours)**
  Concept of Influence lines – Influence lines for reactions, shear force and bending moment in beams – load position for maximum shear force and bending moment at a section in beam – Absolute maximum bending moment in beams- Influence lines for member forces in Trusses – Mriller Bresalay's Principle.

- **DISPLACEMENT OF STATICALLY DETERMINE STRUCTURES** **(10Hours)**
  Determination of slope and deflections of beams using successive integration method – Macaulay's Method- Conjugate Beam Method- Determination of deflection of trusses using virtual work method – Application of Castigliano' s theorem for computing deflection of beam and trusses

- **ANALYSIS OF INDETERMINATE TRUSSES** **(10 Hours)**
  Statically indeterminate structures – Method of consistent deformations for the analysis of trusses

(Total Lectures: 42 hours)

3. Practical

1. Deflection of Cantilever Beam
2. Deflection of Simply Support Beam
3. Deflection of overhanging Beam
4. Shear Centre for Unsymmetrical Sections
5. Study of different models for two and three dimensional structures
6. Force Determination and deflection study of 2D and 3D truss
7. Verification of energy based deflection method for indeterminate truss.
8. Verification of energy based deflection method for indeterminate beam.
9. Boundary conditions effects on determinate and indeterminate structures.

4. Books Recommended

1. R C Hibbler, Structural Analysis, 6th edition, Pearson Prentice Hall, New Delhi, 2006.
2. A Gali, A M Newville, T G Brown, Structural Analysis – A Unified Classical and Matrix Approach, Sixth Edition, Spon Press, UK, 2009.
3. H S Patil, Y D Patil, and J B Patel; Structural Analysis-I, Synergy Knowledge ware Publisher, Mumbai, 2016.
4. P S Gahlot, D Gehlot, Fundamentals of Structural Mechanics, CBS Publisher, New Delhi, 2012.
5. T S Thandavamoorthy, Structural Analysis, Oxford University Press, New Delhi, 2011.

5. Mapping of COs and POs

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

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

6. Mapping of COs and PSOs

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

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

CE 208 Geomatic Surveying

L	T	P	C
3	1	2	4

---

1. **Course Outcomes (COs)**

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

CO1	Establish horizontal control points and preparation of topographic map of hilly region
CO2	Estimate area using concept of geospatial technology and total station survey.
CO3	Compute and measure relief displacement, development of mosaic etc. using principle of photogrammetry.
CO4	Estimate area and volume by field measurement as well as using formulae.
CO5	Compute and analyze area and volume by field measurement as well as using formulae.

2. **Syllabus**

- **TACHEOMETRIC SURVEY** **(06 Hours)**
  Purpose, Principles of Tacheometry, Different Systems of Tacheometry, Various instruments, stadia constants, analytic lens, subtense bar, field work in tacheometry, reduction of readings, errors and precisions, Tacheometric Traversing.

- **GEODETIC SURVEYING** **(06 Hours)**
  Principles - Classification if triangulation systems - Selection of stations - Signals and towers - Baseline measurement and correction - Extension of base - base net - Satellite station - Reduction to center - Introduction to theory of errors and technical terms.

- **GEOSPATIAL TECHNOLOGY** **(12 Hours)**
  GIS: Overview of GIS, data input and output, data management; GPS: Introduction to GPS, Geodesy, Working principle of GPS, Measurement and mapping techniques; Remote Sensing: concepts and fundamentals of remote sensing, Energy sources, Energy interactions, ideal and real remote sensing systems.

- **TOTAL STATION SURVEY** **(05 Hours)**
  Principle, Data observations, Software

- **COMPUTATION OF AREAS AND VOLUMES** **(06 Hours)**
  Areas from field measurements and plans, Different methods, Trapezoidal and Simpson's rule, Plannimeter, Volume by trapezoidal and prismoidal formula, Calculation of

earthwork in cutting and embankment for civil engineering works, Mass haul diagram, Volume by spot levels, Capacity of reservoir.

- **PHOTOGRAMMETRIC SURVEY** **(07 Hours)**
  Introduction, Technical terms, Aerial photogrammetry, Types of photographs, Vertical photographs, Uses of aerial photographs, Flying height and scale, Relief displacement, Stereoscopy, Measurement of parallax and height determination, Mosaic preparation

(Total Lectures: 42 hours, Tutorials: 14 hours)

3. Practical

1. Measurement of Vertical Angle with Vernier Theodolite.
2. Measurement of Vertical Angle with Digital Theodolite.
3. Tacheometric Exercise with different types of Theodolites I.
4. Tacheometric Exercise with different types of Theodolites II.
5. Determination of Tacheometric constant K and C.
6. Exercise on Triangulation Work including satellite Station.
7. Introduction of Area Measuring Equipment – Planimeter (Mechanical and Digital).
8. Evaluation of Area of map with irregular boundary.
9. Demonstration of total station and its uses.
10. Comparison between aerial photographs and map.
11. Determination of height of objects from aerial photographs.
12. Demonstration of GPS and its uses.
13. Remote sensing data analysis and Demonstration on GIS software.

4. Books Recommended

1. W Schofield, Engineering Surveying, Butterworth-Heinemann Publication, New Delhi, 2001.
2. K R Arora, Surveying and Levelling, Vol. II and III, Standard Publications, Delhi, 2000.
3. T M Lille sand and R.W. Kiefer, Remote Sensing and Image Interpretation, 4th Edition, John Wiley and Sons, New York, 2002.
4. N K Agrawal, Essentials of GPS, Spatial Network Pvt. Ltd., Hyderabad, 2006.
5. A M Chandra and S K Ghosh, Remote Sensing and Geographical information System, Narosa Publishing House, New Delhi, 2006.

6. Mapping of COs and POs

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

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

7. Mapping of COs and PSOs

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

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

CE 212 Building and Town Planning

L	T	P	C
4	1	2	6

1. Course Outcomes (COs)

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

CO1	Explain household requirements and role of engineer in planning.
CO2	Explain building regulations and plan approval process in urban area.
CO3	Plan buildings and preparation of approval drawings.
CO4	Prepare architectural and perspective drawings .
CO5	Explain fundamentals of Town Planning .

2. Syllabus

- **PLANNING APPROACH** **(08 Hours)**
  Basic areas in residential buildings, Process of planning, Family requirements and analysis, Conceptual plan outlines, Principles and techniques of functional planning, Planning for building services, Stakeholders' role in changing surrounding area.

- **BUILDING SYSTEMS** **(30 Hours)**
  Concept of art and creativity, Load-bearing, framed and composite structural systems and functional classification of buildings, Residential building forms.

- **RESIDENTIAL BUILDINGS PLANNING** **(08 Hours)**
  Plan preparation for residential units, Structural components, Space forms and analysis, Activity space, Elements of human scale, Size and dimension decisions, Furniture layouts

- **PUBLIC BUILDINGS PLANNING** **(08 Hours)**
  Basic theory of Torsion – Solid shaft – Hollow shaft – Power transmitted by shaft – Composite shafts

- **ARCHITECTURAL COMPOSITION** **(03 Hours)**
  Mass Composition, Principles of elevation development-techniques, Impacts of colour and structure character, landscaping

- **BUILDING BYE LAWS** **(02 Hours)**
  Building byelaws, Provisions in developed and developing Built-Environment, Plan approval process.

- **BUILDING DRAWINGS** **(08 Hours)**
  Key plan, Site plan, Working and approval drawings, One and two Perspective drawings, Foundation, Fundamentals of electrical and plumbing layouts, Building drawing software applications.

- **TOWN PLANNING PRACTICES** **(02Hours)**
  Town Planning: What, Why and How? Issues and national perspectives.

(Total Lectures: 42 hours, Tutorials: 14 hours)

3. Practical

1. Plan sketches on site visits.
2. Study of Building forms and building layout for public schemes.
3. Study of Building forms and building layout for private schemes.
4. Planning of residential buildings.
5. Planning of public buildings.
6. Preparation of drawings for foundation
7. Preparation of drawings for electrical and plumbing
8. Planning of public buildings.
9. Preparation of landscape layout.
10. Preparation of perspective drawings.

4. Books Recommended

1. Comprehensive General Development Control Regulations, Urban Development and Urban
5. Housing Department, GoG, 2017.
2. M G Shah, C M Kale and S Y Patki, Building Drawing: With an Integrated Approach to Built
6. Environment, Tata McGraw-Hill Education, New Dehi, 2002.
3. National Building Code, Bureau of India Standard, New Delhi, 2016.
4. S M Patil, Building Services, Sachin Printers, Mumbai, 2004.
5. Y S Sane, Planning and Designing of Building, Allies Book Stall, Poona, 1990

7. Mapping of COs and POs

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

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

8. Mapping of COs and PSOs

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

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

SEMESTER V

HU 301 Professional Ethics, Economics and Business Management

L	T	P	C
3	1	0	5

1. Course Outcomes (COs)

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

CO1	Identify application of ethics in society and development of understanding regarding Professional ethical issues related to Civil engineering .
CO2	Develop managerial skills to become future engineering managers
CO3	Develop skills related to various functional areas of management (Marketing Management, Financial Management, Operations Management, Personnel Management etc.)
CO4	Build knowledge about modern management concepts (ERP, SCM, e-CRM, etc.)
CO5	Apply knowledge of Economics and Business management aspects in Civil engineering

2. Syllabus

- **PROFESSIONAL ETHICS** **(10 Hours)**
  Introduction, Approaches to Ethics, Meaning of Ethics, Major attributes of Ethics, Business Ethics, Factors influencing Ethics, Importance of Ethics, Ethics in Management, Organizational Ethics, Ethical aspects in Marketing, Mass communication and Ethics - Television, Whistle blowing, Education – Ethics and New Professional, Intellectual Properties and Ethics, Introduction to Professional Ethics, Engineering Ethics, Ethical issues related to Civil Engineering.

- **ECONOMICS** **(06 Hours)**
  Introduction To Economics, Micro and Macro Economics, Applications and Scopes Of Economics, Demand Analysis, Demand Forecasting, Factors Of Production, Types Of Cost, Market Structures, Break Even Analysis.

- **MANAGEMENT** **(09 Hours)**
  Introduction to Management, Features Of Management, Nature Of Management, Development of Management Thoughts – Scientific Management By Taylor and Contribution of Henry Fayol, Coordination and Functions Of Management, Centralization and Decentralization, Decision Making; Fundamentals of Planning; Objectives and MBO; Types of Business Organizations: Private Sector, Public Sector and Joint Sector;

Organizational Behavior: Theories of Motivation, Individual and Group Behavior, Perception, Value, Attitude, Leadership.

- **FUNCTIONAL MANAGEMENT** **(14 Hours)**
  Marketing Management: Core Concepts Of Marketing, Marketing Mix (4p), Segmentation – Targeting – Positioning, Marketing Research, Marketing Information System, Concept of International Marketing, Difference Between Domestic Marketing and International Marketing; Operations Management: Introduction to Operations Management, Types of Operation Systems, Types of Layouts, Material Handling, Purchasing and Store System, Inventory Management; Personnel Management: Roles and Functions of Personnel Manager, Recruitment, Selection, Training, Industrial Dispute, Collective Bargaining; Financial Management: Goal of Financial Management, Key Activities In Financial Management, Organization of Financial Management, Financial Institutions, Financial Instruments, Sources of Finance

- **MODERN MANAGEMENT ASPECTS** **(03 Hours)**
  Introduction To ERP, e – CRM, SCM, RE – Engineering, WTO, IPR Etc.

Tutorial: Case Study Discussion, Group Discussion, Management games and Assignments / Mini projects and presentation on related Topics

(Total Lectures: 42 hours, Tutorials: 14 hours)

3. Books Recommended

1. V Balachandran and Chandrasekaran, Corporate Governance, Ethics and Social Responsibility, PHI, 2nd Edition, 2011.
2. L M Prasad, Principles and Practice Of Management, Sultan Chand and Sons, 8th Edition, 2015.
3. T. R. Banga and S C Shrama, Industrial Organisation and Engineering Economics, Khanna
   Publishers, 25th Edition, 2015.
4. E. Everett, Adam, R J Ebert, Production and Operations Management, Prentice Hall of India, 5th edition, 2012.
5. P Kotler, K L Keller, A Koshi and M Jha, Marketing Management – A South Asian Perspective, Pearson, 14th Edition, 2014.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 301 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 BOQ and tender.

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** **(12 Hours)**
  Estimation of earthwork and masonry, flooring, walls, openings, RCC components, staircase, timber and steel work, load bearing and framed structures.

- **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)**
  Basic principles and purpose, types and details.

- **RATE ANALYSIS** **(10Hours)**
  Factors affecting rates of building items, output of work force, building and typical civil engineering items, schedule of rates

- **ABSTRACTING** **(03 Hours)**
  BS methods of abstracts, abstract statements, cost analysis, BOQ and tenders.

(Total Lectures: 42 hours, Tutorials: 14 hours)

3. Practical

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.

4. Books Recommended

1. A Aggarwal and A K Upadhyay, Civil Estimating, Costing and Valuation, Kataria and Sons, New Delhi, 1994.
2. B N Dutta, Estimating and Costing, S. Dutta and Co., Lucknow, 1995.
3. G S Birdie, Estimating and Costing, Dhanpat Rai and Sons, Delhi, 1996.
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, 1998.

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

CE 303 Environmental Engineering II

L	T	P	C
3	1	2	5

---

1. **Course Outcomes (COs)**

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

CO1	Describe the need of collection and treatment of municipal wastewater
CO2	Summarize the Physical, Chemical and Biological characteristics of wastewater
CO3	Design an appropriate sewerage system.
CO4	Differentiate various unit operations and processes with design applications
CO5	Explain municipal solid waste sources, its characteristics and treatment options

2. **Syllabus**

- **WASTEWATER GENERATION, COLLECTION AND CONVEYANCE(10 Hours)**
  Wastewater Quantity - Classification of wastewater - Sewerage system for domestic wastewater and storm water - Collections, and appurtenances - Design and layout of sewerage systems - Maintenance of sewerage systems - Physical, Chemical and Biological characteristics and their significance.

- **PRIMARY TREATMENT OF WASTEWATER (05 Hours)**
  Objectives of Wastewater treatment- Treatment methods: Unit Operations and Processes Design criteria - Design of primary treatment System.

- **SECONDARY TREATMENT OF WASTEWATER (10 Hours)**
  Concepts of Biological treatment and removal mechanism – Aerobic and Anaerobic systems - Design of suspended and attached growth processes – Introduction to extended aeration processes and waste stabilization pond - Design of anaerobic system.

- **WASTEWATER DISPOSAL AND SLUDGE HANDLING (07 Hours)**
  Alternative disposal methods - Self purification of stream - Standards for disposal alternatives, natural purification of polluted streams. Quantity and quality of sludge, Methods of sludge treatment: sludge digestion and drying beds , Disposal of sludges. House drainage system - traps and sanitary fitting - Low cost sanitation Systems.

- **MUNICIPAL SOLID WASTES (10 Hours)**

Sources and collection of municipal solid wastes, characteristics of solid wastes, treatment and disposal.

(Total Lectures: 42 hours)

3. Practical

1. Determination of solids in wastewater.
2. Determination of pH of water and wastewater.
3. Measurement of colour.
4. Determination of carbonate, bi-carbonate and hydroxide alkalinity.
5. Determination of oil and grease in water.
6. Determination of phosphorus as PO4-3.
7. Determination of sulphate.
8. Determination of Biochemical Oxygen Demand of wastewater.
9. Determination of Chemical Oxygen Demand of a given sample.
10. Determine MLSS and MLVSS

4. Books Recommended

1. Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, Tata McGraw-Hill, New Delhi, 2003.
2. G L Karia and R A Christian, Wastewater Treatment Concepts and Design Approach, Prentice Learning Private Ltd., New Delhi, 2013.
3. Manuel of Sewerage and Sewage Treatment, CPH and EE organization, Ministry of Works and Housing, Govt. of India, New Delhi, 2006.
4. S R Qasim, and G Zhu, Wastewater Treatment and Reuse, CRC Press, Taylor and Francis Group, New York, 2018.
5. M L Davis, Water and Wastewater Engineering, McGraw-Hill, New Delhi, 2010.

5. Mapping of COs and POs

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

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

6. <u>Mapping of COs and PSOs</u>

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

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

CE 321 Advanced Geotechnical Engineering

L	T	P	C
3	0	1	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 stress distribution, slope stability and earth pressure
CO3	Evaluate the load carrying capacity and settlement of shallow foundation
CO4	Analyse the soil condition and design foundation system
CO5	Evaluate the load carrying capacity of pile foundation

2. Syllabus

- **GEOTECHNICAL INVESTIGATION** **(03 Hours)**
  Sub soil exploration by Geo Physical methods – Seismic method, Electrical resistivity method – Borelog sheet– Sub soil Investigation..

- **STRESS DISTRIBUTION** **(05 Hours)**
  Causes of stress in soil- Geostatic stress- Boussinesq's equation-Stresses due to different types of loading- Isobar diagram and pressure bulb- New-mark's influence chart, Approximate methods-Contact pressure distribution.

- **EARTH PRESSURE AND RETAINING STRUCTURES** **(08 Hours)**
  Definition - Active - Passive and Earth pressure at rest conditions, Rankine's theory-Coulomb's theories of earth pressure - Graphical Method - Types of Retaining walls-Principle of design of retaining walls - Analysis and Design of Retaining structures.

- **STABILITY OF SLOPE** **(06 Hours)**
  Types of slope failures-Different factors of safety-Infinite slope - Finite slope –Wedge failure--Friction Circle Method- - Taylors stability number- Swedish method-Applications to design of earth dam, choice of shear parameters - Total and effective stress analysis.

- **BEARING CAPACITY OF SOIL** **(05 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** **(03 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** **(03 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 geosynthetic.

(Total Lectures: 42 hours)

3. Books Recommended

1. J E Bowles, Foundation Analysis and Design, McGraw-hill, New Delhi, 1997.
2. K R Arora, Soil Mechanics and Foundation Engineering (Geotechnical 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 Education Private Limited, New Delhi, 2009.

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

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

5. Mapping of COs and PSOs

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

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

CE 323 Engineering Geology

L	T	P	C
3	0	0	3

1. **Course Outcomes (COs)**

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

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

2. **Syllabus**

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

- **PROCESSES IN GEOLOGY** **(10 Hours)**
Igneous processes, Bowen's reaction principle, textures and structures of plutonic and volcanic rocks, Weathering processes, Sedimentary processes, Structures of sedimentary rocks, Effects of pressure and temperature, Metamorphic rocks and structures, Geological work of Rivers, Sea/Oceans, Glaciers, Wind and Deposits .

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

- **SITE INVESTIGATION** **(07 Hours)**
Geophysical Methods: Resistivity and Seismic Refraction methods, Earthquakes, Landslides, Subsidence, Erosion, Karst formations, Engineering properties of Rocks, Site selection for Slopes, Tunnels and Foundations, Rock as a construction material.

(Total Lectures: 42 hours)

3. Books Recommended

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

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 361 Industrial Safety and Environment

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 water quality and quantity requirements for given uses
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 (06Hours)**
  Terminologies related to safety management, safety management systems, safety climate, safety organization structure, safety culture and performance management, roles and Responsibilities of various persons for managing safety in construction, project management techniques for safety management in construction.

- **PREVENTION OF ACCIDENTS (08 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 (08 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 (08 Hours)**

Construction safety related acts and rules (central act, central and state rules), building and other construction workers (BOCW) act, 1996 and central rules, 1998, 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 (RandA) 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: 42 hours)

3. Books Recommended

1. R E Levitt and N M Samelson, Construction Safety Management, John Wiley and Sons, New York, 1993.
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

-0 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

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

L	T	P	C

CE 363 Environmental Management

3	0	0	3

1. **Course Outcomes (COs)**

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

CO1	Analyze local and global environmental impact issues like water pollution, air pollution, noise pollution, global warming
CO2	Evaluate important Indian and global environmental protection acts and protocols.
CO3	Describe EIA, Environmental Audit and ISO: 14001 and their methodologies.
CO4	Apply legal provisions and statutory requirements for environmental protection
CO5	Understand Government Environmental Policy and Guidelines

2. **Syllabus**

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

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

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

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

- **GLOBAL ENVIRONMENTAL STANDARDS (09 Hours)**

ISO 14000 introduction – General description of ISO 14001 – Environment Management System (EMS) – Key elements of ISO 14001 and EMS

(Total Lectures: 42 hours)

3. Books Recommended

1. G M Masters and W P Ela, Introduction to Environmental Engineering and Science, Pearson Prentice Hall Inc, New Delhi, 2008.
2. H S Peavy and G Tchobanoglous, Environmental Engineering, McGraw Hill Co, New Delhi, 2004.
3. LW Canter, Environmental Impact Assessment, Tata McGraw Hill Co, Singapore, 1996.
4. K Thakur, Environmental protection law and policy in India, Deep and Deep publishers, New Delhi, 1997.
5. S K Dhameja, Environmental Engineering and Management, S. K. Kataria and Sons, Delhi. 2004.

4. Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	3	3	2	3	3	3	3
CO2	3	3	3	2	2	3	2	1	3	3	3	2
CO3	3	3	2	2	1	3	2	3	3	3	3	3
CO4	3	3	1	1	1	3	3	3	3	2	1	3
CO5	3	3	2	2	2	3	3	2	3	3	3	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 367 Rural Planning and Management

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Learn rural settlement significance in national perspective
CO2	Study Physical and Social Infrastructure needs
CO3	Cultural planning, Low-cost building and Smart village amenities.
CO4	Explain the role of rural institutional setup and Government schemes and policies.
CO5	Preparation of Planning and management of common facilities for village clusters

2. Syllabus

- **INTRODUCTION** **(04 Hours)**
  Introduction: Meaning and Scope and overview of rural development: Historical perspective Rural Development Programmes in India. Problem / perception and identification; Public Rural Area Planning – Programmes / Policies / Schemes for rural development, their coverage and outcomes.

- **RURAL INFRASTRUCTURE DEVELOPMENT** **(10 Hours)**
  Improvement of core physical infrastructure and social infrastructure and augmentation of housing stock, water supply, sanitation, solid waste health and educational facilities. Conservation of rural environment, form and structure, its art and architecture.

- **TECHNOLOGY MISSIONS** **(06 Hours)**
  Five year plans on rural planning and development, various sectoral development programmes, interdependence and efficacy of socio-economic and infrastructural sectors.

- **SETTLEMENT PLANNING AND ANALYSIS** **(07 Hours)**
  Definitions need growth, distribution and classification of rural settlements, size from function and morphology of rural settlements. Types, activity, environment and economic interface in rural habitat, technology in rural settlement; Mobility between rural and Urban Areas. Planning of village center. Planning and management of village clusters planning. Low cost and Vernacular CONSTRUX for the development of rural area. Concept of Ru-Urban.

- **AGRICULTURAL ASPECT** **(06 Hours)**

Allied activities, agriculture land uses economic system and occupation productivity, expenditure and framing system Impact of modern technology, transport facilities, media and communication and trends at national and International level on agriculture.

- **INSTITUTIONS AND ORGANISATIONS (07 Hours)**

Rural bank, Co-operatives, marketing and public administration Zila Parishad, Block Semity and Gram-Panchayat, powers and function.

(Total Lectures: 42 hours)

3. Books Recommended

1. G P H Panel of Experts, Rural Development: Indian Context, Gullybaba Publishing House, 2015.
2. K Singh, Rural development: Principles, policies and management, Sage Texts, New Delhi, 2009.
3. M D Afsar-Alam, Planning and Rural development, Rajat Publication, 2011.
4. S Singh and K K Ali, Environmental Planning for Rural development, Sarup and Son, 2012.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 369 Transportation Safety and Environment

L	T	P	C
3	0	0	3

1. <u>Course Outcomes (COs)</u>

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
CO5	Explain the importance of Environmental Impact Assessment for transportation projects

2. <u>Syllabus</u>

- **INTRODUCTION** **(08 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 and Crash Problem Diagnosing, Crash Problems into Solutions and 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** **(06 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** **(07 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 and Capacity Impacts; Roadway Impacts, Construction Impacts, Environmental Impact Assessment, Environmental Impact Statement, Environment Audit, Typical case studies.

(Total Lectures: 42 hours)

3. Books Recommended

1. R Lamm, B P Sarianos and T Mailaender, Highway Design and Traffic Safety Engineering Handbook, McGraw Hill Publishing, New York, 1999.
2. G John, TRiki and A Chadwick, Introduction to Environmental Impact Assessment, Routledge, Oxon, 2007.
3. C Larry, Environmental Impact Assessment, McGraw Hill Inc. Singapore, 1996.
4. J G Rau and D C Wooten, Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.
5. Relevant IRC and NHAI guidelines.

4. 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

-0 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	2	1	3
CO4	1	1	2
CO5	1	2	2

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

CE 371 Fundamental of GIS and Remote Sensing

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 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** **(07 Hours)**
  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.

- **IMAGE INTERPRETATION AND DIGITAL IMAGE PROCESSING** **(07 Hours)**
  Interpretation Procedure, Strategies, Keys, Equipments, Digital Image Processing, Rectification and Restoration, Enhancement of Image, Image Transformation, Classification and Analysis.

- **GEOGRAPHICAL INFORMATION SYSTEM** **(07 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.

- **DATA MODELS** **(07 Hours)**
  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.

- **SOFTWARE** **(05 Hours)**

  GIS and Image interpretation Software, Salient features, Capabilities and Limitations.

- **APPLICATIONS** **(05 Hours)**

  Application of Remote Sensing / GIS in Civil Engineering, Case studies, Integration of GIS and Remote Sensing, Management and Monitoring of various pollution, conservation of natural sources and coastal zone management.

(Total Lectures: 42 hours)

3. 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.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 373 Building Information Modelling

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	Apply concepts of BIM in traditional construction practice
CO2	Prepare basic modelling of buildings
CO3	Design advanced modelling of building components and elements
CO4	Illustrate nD modelling in BIM
CO5	Conduct advanced analysis on BIM models

2. **Syllabus**

- **INTRODUCTION** **(06 Hours)**
  Introduction to BIM process and integrated project delivery, nD modelling, BIM software systems and guidelines to choosing different BIM software systems.

- **BASIC MODELLING** **(08 Hours)**
  Introduction of modelling environment and tools, modelling approaches to producing plans, 3D models, views and sections of buildings, creating an initial sample of 3D BIM model using a BIM authoring software, modelling of building including basic and vital elements, production of plans, views and 3D models, annotations and preparations of sheets for printing and publishing.

- **nD MODELLING** **(08 Hours)**
  Introduction to aspects of nD modelling, scheduling and quantity take-offs using BIM-enabled systems and export to spreadsheets, Production of 4D program in 4D BIM software, cost estimation, producing cost estimates in 5D BIM software.

- **INTEROPERABILITY IN BIM** **(07 Hours)**
  Basics about interoperability, export formats and applications, exchange of information through IFC, COBie, BIM 360 Glue, mobile BIM

- **ADVANCED BIM** **(07 Hours)**
  Clash detection, overview of clash detection tools, use of software to detect/resolve clashes in a BIM model, project collaboration using cloud/mobile BIM systems and common data environments.

(Total Lectures: 42 hours)

3. Books Recommended

1. R Sacks, C Eastman, G Lee and P Teicholz, BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, Third Edition, John Wiley and Sons, Hoboken, 2018.
2. B Hardin and D McCool, BIM and Construction Management: Proven Tools, Methods, and Workflows, John Wiley and Sons, Hoboken, 2015.
3. W Kymmell, Building Information Modeling: Planning and Managing construction Projects with 4D CAD and Simulations: Planning and Managing Construction Projects with 4D CAD and Simulations, McGraw Hill Professional, New York, 2008.
4. B Kumar, A Practical Guide to Adopting BIM in Construction Projects, Whittles Publishing, Glasgow, 2015.
5. K Kensek and D Noble, Building Information Modeling: BIM in Current and Future Practice, John Wiley and Sons, Hoboken, 2014.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

L	T	P	C

CE 375 Mechanics of Solids

3	0	0	3

1. Course Outcomes (COs)

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

CO1	Apply knowledge of the fundamental properties of various materials and analyse the elastic member using basic principles.
CO2	Analyse the beam to construct the shear force and bending moment diagram considering various loadings
CO3	Analyse different types of springs
CO4	Evaluate the problems related to structural member subjected to axial forces, torsion and bending
CO5	Apply concept of failure theories while designing structural members.

2. Syllabus

- **STRESSES AND STRAINS** **(05 Hours)**
  Concept of stresses and strains – Types of stresses – Hook's Law – Lateral strain – Poisson's ratio – Elongation due to own weight – Tapering sections – Varying cross sections – Composite sections – Relation between Modulus of Elasticity, Modulus of Rigidity and Bulk Modulus – Thermal Stresses – Eccentric load – Limit of eccentricity – Core /Kernel of the section.

- **SHEAR FORCE DIAGRAM AND BENDING MOMENT DIAGRAM** **(06 Hours)**
  Types of beams – Types of supports – Types of loads – shear force – Bending moment – Sign conventions – Overhanging beams – Point of contra flexure – Varying loads – Relation between Shear Force and Bending Moment.

- **STRESSES IN BEAMS** **(05 Hours)**
  Theory of simple bending – Moment of Resistance – Beam of Uniform strength – Flitched beams – Shear stress concept – Derivation of shear stress – Shear stress variation in rectangular, circular, T-section and I – section, Eccentric load – Limit of eccentricity – Core /Kernel of the section.

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

- **TORSION** **(04 Hours)**

Basic theory of Torsion – Solid shaft – Hollow shaft – Power transmitted by shaft – Composite shafts.

- **SPRINGS** **(04 Hours)**
  Types of springs – Close coiled helical spring subjected to axial load and twist – Leaf springs – Semi elliptical and Quarter elliptical leaf springs.

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

- **THIN CYLINDERS** **(03 Hours)**
  Stresses in cylinders – Thin cylinders and thin spheres – Volumetric strain – Wire wound thin cylinders.

- **STRAIN ENERGY** **(03 Hours)**
  Strain energy – Resilience – Strain energy due to Tension and compression - Strain energy due to freely falling load

- **THEORIES OF FAILURES** **(03 Hours)**
  Various hypotheses: Maximum principal stress theory, maximum strain theory, maximum shear stress theory, maximum strain energy theory, maximum shear strain energy theory. Problem based on above all theories.

(Total Lectures: 42 hours)

3. Books Recommended

1 S Timoshenko and D H Young, Elements of Strength of Materials, Tata Mc Graw Hill, New Delhi, 2006.
2 G H Ryder, Strength of Materials, English Language Book Society, New Delhi, 2006.
3 S S Bhavikatti, Strength of Materials, Vikas Publication House, New Delhi, 2007.
4 E P Popov and T A Balan, Engineering Mechanics of Solids, 2nd Edition, Prentice Hall of India Pvt Ltd, New Delhi, 2002.
5 F P Beer and S J Johnston, Strength of Materials, Tata Mc Graw Hill, New Delhi, 2004.

4. Mapping of COs and POs

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

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

5. 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

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

CE 377 Introduction to Earthquake 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	Explain ground motion, magnitude, intensity, frequency, plate tectonics and various terminologies related to earthquake
CO2	Compute ground motion intensity measures and attenuation relationships.
CO3	Explain theory of seismic analysis and its philosophy
CO4	Apply the building code provisions in the design of structural systems.
CO5	Analyse the structures subjected to earthquakes using basics of structural dynamics

2. Syllabus

- **INTRODUCTION** **(02 Hours)**
  Inner and Outer core of earth plate tectonics and its circulation – Earthquake types – Types of faults – Different types of seismic waves – Measuring instruments of earthquake – Strong ground motion and its characteristics - Magnitudes intensity of earthquake.

- **SEISMIC TECTONIC / SEISMIC ENVIRONMENT OF INDIAN REGION** **(02 Hours)**
  Seismic Geography and tectonic features of India – Seismic zones earthquake in India.

- **SEISMIC EFFECT ON STRUCTURES** **(06 Hours)**
  Inertia force in structures and its foundation deformations in structure – Horizontal and vertical movement of structures - Drift - Twisting of structures during earthquake – Building codes – Importance of Architectural features – Building layout and its configuration, Crumple joints, IS: 4326, ponding effect, elephant foot effect.

- **SEISMIC DESIGN PHILOSOPHY** **(10 Hours)**
  Earthquake Design philosophy – Acceptance damage and ductility of building and capacity design concept – Quality control – Importance of Flexibility of structures – Indian seismic codes, IS: 1893, IS : 16700, IS :13920, water tank, building, chimney etc.

- **SEISMIC EFFECTS ON MASONRY STRUCTURES** **(06 Hours)**
  Behaviour of Brick Masonry and stone masonry under earthquake engineering – Construction aspects to improve the behaviour of masonry wall – selection of building

materials – Structure configuration of masonry buildings – Earthquake resistant features of masonry work, Earthquake Structure.

- **SEISMIC EFFECT ON REINFORCED CONCRETE BUILDING (10 Hours)**
  Reinforced concrete buildings – Role of slab and masonry works – Behaviour R C Beams under seismic loadings, infill wall effect, shear wall position and effect.

- **BEHAVIOUR OF BEAM and COLUMN JOINTS (02 Hours)**
  Behaviour of RC Beams column joints – Seismic effect on Open – Ground storey building – Behaviour of short column – Energy absorption of FRC joint under cyclic loading.

- **BASE ISOLATION SYSTEM (04 Hours)**
  Introduction to seismic dampers – Viscous damper – Friction dampers – Yielding devices, active isolation method, snubber for power reactor pipe lines, Auxiliary mode of vibration.

(Total Lectures: 42 hours)

3. Books Recommended

1. P Agrawal and M Sprikhande, Earthquake Resistant Design of Structures, 1st edition, Prentice Hall of India Pvt Ltd, New Delhi, 2004.
2. Indian seismic codes, IS: 1893, IS : 16700, IS :13920.
3. R I Skinner and W H Robinson, An Introduction to seismic Isolation John Wiley and sons, New York, 1999.
4. J S Ambrose and D Vergun, Design for Earthquakes, John Wiley and Sons INC, New York, 1999.
5. T Paulay and M J N Priestley, Seismic Design of reinforced Concrete and Masonry buildings, John Wiley and Sons, New York, 1999.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 379 Introduction to Structural 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	Describe the materials and structural behaviour in analyzing and design of structures.
CO2	Illustrate and evaluate the forces and distribution of stresses due to various types of mechanical forces
CO3	Explain the concepts of strength through mass, i.e. behaviour of slabs, beams, columns, plates etc. under the different load conditions
CO4	Hypothesize the concepts of strength through form i.e. behaviour of shells, folded plates, tensegrity structures, etc. under different loading
CO5	Analyse the structure based on geometry forces.

2. Syllabus

- **STRUCTURE FORCES, MOMENT AND EQUILIBRIUM** **(08 Hours)**
  Review of forces, moment, couples, loads – Equilibrium conditions – Supports – Simple beam –Cantilever beam – Trusses – Cables.

- **STRESS AND STRAIN** **(08 Hours)**
  Axial (tension and Compression) – Bending – Shear – Torsion – Shear force and bending moment diagrams– Failure Criteria.

- **STRENGTH THROUGH MASS** **(10 Hours)**
  Approximate analysis and Conceptual design of slabs – Plates – Beams – Columns – Case studies –towers – frames.

- **STRENGTH THROUGH FORMS/SHAPES** **(10 Hours)**
  Various types of shells – Folded Plates – Tensigrity Structures – Introduction to 3-dimension space structures – Innovative case studies.

- **MATERIALS FOR DESIGN** **(06 Hours)**
  Steel - Concrete – Composite – Fiber Reinforced Plastic Composite – Innovative materials.

(Total Lectures: 42 hours)

3. Books Recommended

1 J P Parikh, Understanding concept of Structural Analysis and Design, Charotar Publishing House, Anand, 2000.
2 Beer and Johnston, Mechanics of Materials, 3rd Edition, Mc Graw Hill Publication Inc., New Delhi 2004.
3 N Subramanian, Principles of Space Structures, 2nd Edition, Wheeler Publishing, New Delhi, 1999.
4 G Levis, Selection of Engineering Materials, Prentice Hall college division, Singapore, 1989.
5 G S Ramaswamy, M Eekhout and G R Suresh, Analysis, Design and Construction of Steel Space Frames. Thoma Telford, London, 2002.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 381 Rehabilitation and Strengthening of Structures

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 various distress and damages to concrete structures and understand the importance of maintenance of structures
CO2	Evaluate the damage to structures using various tests and how to conduct field monitoring and non-destructive evaluation of concrete structures.
CO3	Compare the various repair techniques and strategies of damaged/corroded structures and its mechanisms
CO4	Describe the basic concepts of serviceability and durability of concrete structures
CO5	Evaluate the damage in structure and apply preventive measures.

2. Syllabus

- **CAUSES FOR DISTRESS IN STRUCTURE** **(08 Hours)**
  Philosophy and definition, causes of failure, failure in ancient time and recent times - deficiency in design drag, material production, maintenance etc.- failure related problems; manmade and natural failure or damage; diagnosis of failure; change in appearance on an exposure, chemical deterioration, mechanical deterioration - cracking in buildings. failure of flat roofs, balconies, trenches, dams, piles abutments piers, silos, chimney, cooling towers, reinforced cement concrete (rcc) frames, failure information and analysis. format of investigation - shear, torsion compression failure, erection difficulty, failure in tanks silos, space frame, precast assemblies prestressed concrete structure, formwork failure, case studies.

- **MAINTENANCE AND REPAIR OF STRUCTURES** **(08 Hours)**
  Need for maintenance and repairs, Inspection of structures for repairs and maintenance, methods for repairs, Material and methodology for repairs, cost of repair and maintenance, repair techniques for various structural elements.

- **REHABILITATION OF DISTRESS STRUCTURES** **(09 Hours)**
  Inspection and testing of distressed structures, condition assessment using destructive and non-destructive tests, techniques for rehabilitation of concrete structures, retrofitting of structures.

- **STRUCTURE ASSESSMENT AND LEGAL ASPECTS** **(08 Hours)**

Art of structure assessment, method of testing, Indian standard (I.S.) code provisions for testing of materials, safety assessment, legal aspects in connection to failure a repair.

- **PREVENTIVE MEASURES FOR DURABILITY OF STRUCTURES (09 Hours)**
  Proper selection and specification of materials, construction quality, quality assurance, the use of modern techniques for construction, proper design, better workmanship.

(Total Lectures: 42 hours)

3. Books Recommended

1 T Kay, Assessment and Renovation of Concrete Structures (Concrete Design and Construction Series), Longman Scientific & Technical, 1992.
2 K S Rakshit, Construction Maintenance and Repair of Highway Bridge, M/s. New Central Book Agency (P) Ltd., New Delhi, 2008.
3 R N Raiker, Learning from failures, Deficiencies in Design, Construction and Service, New Bombay, India: R and D Centre, Structwel Designers and Consultants, 1987.
4 P C Varghese, Maintenance, Repair and Rehabilitation and Minor works of Buildings, PHI Learning Private Limited, New Delhi, 2014.
5 J Bhattacharjee, Concrete Structures Repair, Rehabilitation and Retrofitting, CBS Publishers and Distributors, New Delhi, 2018.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 305 Seminar

L	T	P	C
0	0	2	1

---

1. Course Outcomes (COs)

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

CO1	Identify and discuss the current real-time issues in the chosen field/area of Civil Engineering.
CO2	Learn the art of literature survey on identified problem pertaining to Civil Engineering.
CO3	Compile the information in a logical manner to produce state-of-the-art technical report.
CO4	Develop technical report writing and presentation skills.
CO5	Develop professional ethics and life long learning skills

2. Description

Each candidate is required to present one seminar on any chosen topic connected with the field of specialization. The topic shall be chosen in consultation with the concerned faculty advisor. Preparation and Presentation of a seminar is intended to investigate an in-depth review of literature, to prepare a critical review and to develop confidence for making a good presentation. Assessment is based on the presentation and contents of the seminar report prepared. A report has to be submitted in the prescribed format and seminar shall be evaluated by the respective department committee.

(Total Lectures: 42 hours)

3. Mapping of COs and POs

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

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

4. Mapping of COs and PSOs

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

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

CE 302 Structural Analysis - II

L	T	P	C
3	1	2	5

1. Course Outcomes (COs)

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

CO1	Analyse displacements and internal forces of statically indeterminate beams by classical, iterative and matrix methods
CO2	Analyse Axial force, Shear force and Bending moment in frames subjected to lateral loads using approximate methods
CO3	Analyse internal forces and reactions for two hinged and three hinged arches
CO4	Analyse 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** **(04 Hours)**
  Concept of fixed and propped cantilever beams.

- **ANALYSIS OF INDETETERMINATE STRUCTURES WITH DISPLACEMENT BASED METHODS** **(10 Hours)**
  Slope Deflection Method – Moment Distribution method for continuous beam and rigid frame with and without support settlement with and without sway .

- **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** **(05 Hours)**
  Introduction to force and displacement method of analysis-stiffness method of analysis using direct element approach.

- **ANALYSIS FOR MOVING LOADS FOR INDETERMINATE BEAMS** **(04 Hours)**
  Construction of influence line for beams, Application of Mueller Breslau Principle.

(Total Lectures: 42 hours)

3. Practicals

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

4. Books Recommended

1 C S Reddy, Basic Structural Analysis, 2nd Edi, Tata Mc Graw Hill, New Delhi, 2007.
2 C K Wang, Indeterminate Structural Analysis, Mc Graw Hill, Singapore, 1989.
3 A S Meghere and S K Deshmukh, Matrix method of Structural Analysis, Charotar Publishing House, Anand, 2003.
4 L S Negli and R S Jangid, Structural Analysis, Tata Mc Graw Hill, New Delhi, 1999.
5 S B Junarkar and H J Shah, Mechanics of Structures, Vol-2, Charotar Publishing House, Anand, 1996.

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

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

SEMESTER VI

HU 410 Innovation, Incubation and Entrepreneurship

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 the concepts of Entrepreneurship
CO2	Develop skills related to various functional areas of management (Marketing Management, Financial Management, Operations Management, Personnel Management etc.)
CO3	Develop skills related to Project Planning and Business Plan development
CO4	Demonstrate the concept of Innovation, Intellectual Property Rights (IPR) and Technology Business incubation
CO5	Build knowledge about Sources of Information and Support for Entrepreneurship

2. Syllabus

- **CONCEPTS OF ENTREPRENEURSHIP (10 Hours)**
  Scope of Entrepreneurship, Definitions of Entrepreneurship and Entrepreneur, Characteristics of an Entrepreneur, Entrepreneurial Development models and Theories, Entrepreneurs Vs Managers Classification of Entrepreneurs; Major types of Entrepreneurship – Techno Entrepreneurship, Women Entrepreneurship, Social Entrepreneurship, Intrapreneurship (Corporate entrepreneurship), Rural Entrepreneurship, Family Business etc.; Problems for Small Scale Enterprises and Industrial Sickness; Entrepreneurial Trait Tests; Entrepreneurial Environment – Political, Legal, Technological, Natural, Economic, Socio – Cultural etc. ; Motivation; Business Opportunity Identification.

- **FUNCTIONAL MANAGEMENT AREA IN ENTREPRENEURSHIP (12 Hours)**
  Marketing Management: Basic concepts of Marketing, Development of Marketing Strategy and Marketing plan, Online Marketing, New Product Development Strategy, Operations Management: Basic concepts of Operations management, Location problem, Development of Operations strategy and plan, Personnel Management: Main operative functions of a Personnel Manager, Development of H R strategy and plan Financial Management: Basics of Financial Management, Ratio Analysis, Capital Budgeting, Working Capital Management, Cash Flow Statement, Break Even Analysis.

- **PROJECT PLANNING** **(06 Hours)**
  Product Development – Stages in Product Development; Feasibility analysis – Technical, Market, Economic, Financial etc.; Project report; Project appraisal; Setting up an Industrial unit – procedure and formalities in setting up an Industrial unit; Business Plan Development.

- **PROTECTION OF INNOVATION THROUGH IPR** **(04 Hours)**
  Introduction to Intellectual Property Rights – IPR, Patents, Trademarks, Copy Rights.

- **INNOVATION AND INCUBATION** **(06 Hours)**
  Innovation and Entrepreneurship, Creativity, Green Technology Innovations, Grassroots Innovations, Issues and Challenges in Commercialization of Technology Innovations, Introduction to Technology Business Incubations, Process of Technology Business Incubation.

- **SOURCES OF INFORMATION AND SUPPORT FOR ENTREPRENEURSHIP** **(04 Hours)**
  State level Institutions, Central Level institutions and other agencies.

(Total Lectures: 42 hours)

3. Books Recommended

1 V Desai, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, New Delhi, 2011.
2 P M Charantimath, Entrepreneurial Development and Small Business Enterprises, Pearson Education, Singapore, 2018.
3 H David, Entrepreneurship: New Venture Creation, Pearson Education, Singapore, 2016.
4 P Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation and Review, Tata McGraw Hill, New Delhi, 2019.
5 T R Banga and S C Shrama, Industrial Organisation and Engineering Economics, Khanna Publishers, New Delhi, 2015.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 304 Highway Engineering

L	T	P	C
3	1	2	4

1. **Course Outcomes (COs)**

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

CO1	Carry out laboratory investigations for characterization of highway materials.
CO2	Carry out design of geometric elements of highways
CO3	Carry out design of flexible & rigid pavement.
CO4	Plan and conduct traffic studies and analyze traffic condition
CO5	Synthesize pavement condition with maintenance needs.

2. **Syllabus**

- **HIGHWAY PLANNING AND ADMINISTRATION (03 Hours)**
  History of road development, Road planning in India, Highway administration, Highway project preparation, surveys and investigations, project estimates.

- **HIGHWAY GEOMETRICS (06 Hours)**
  Design controls and criteria, Cross sectional elements, Sight distance considerations, Design of horizontal and vertical alignment.

- **HIGHWAY MATERIAL AND CONSTRUCTION (09 Hours)**
  Sub grade soil investigation and properties, Desirable properties of aggregates and bitumen, Testing of aggregates, binders and mixes, IRC specifications for materials, Construction of low cost roads, WBM, WMM, Types of bituminous surfaces and C.C. roads, IRC specification for construction, Tools, Equipment and Plants, Highways in hilly region, waterlogged areas and other area specific issues.

- **PAVEMENT DESIGN (09 Hours)**
  Types of pavements, Design factors and analysis, Design of flexible and rigid pavements, various design methods, IRC code of practice.

- **HIGHWAY MAINTENANCE (04 Hours)**
  Pavement evaluation, Surface and sub-surface drainage, Maintenance of bituminous and concrete roads, Concepts of overlay design, Pavement Management System.

- **TRAFFIC ENGINEERING (11 Hours)**

Basic parameters, Traffic studies, Different traffic control devices, Signs, markings, signals, Traffic management and regulation, Concepts of at-grade and grade separated intersections, highway capacity, level of service.

(Total Lectures: 42 hours)

3. Practical

1 Determination of C.B.R. value of Subgrade soil.
2 Determination of Abrasion value and Shape Index.
3 Determination of Impact and Ten percent fines value.
4 Determination of soundness of aggregate.
5 Determination of ductility.
6 Determination of softening point.
7 Determination of penetration value.
8 Determination of viscosity.
9 Determination of bitumen content in bituminous mix by centrifuge extraction.
10 Mixed Traffic Volume Study.
11 Spot speed study
12 Speed and delay study
13 Origin and Destination survey.

4. Books Recommended

1. S K Khanna, C E G Justo and A Veeraragavan, Highway Engineering, Nem Chand and Bros., Roorkee, 2015.
2. L R Kadiyali and N B Lal, Principles and Practices in Highway Engineering (including Expressway and Airport Engineering), Khanna Publishers, New Delhi, 2017.
3. E J Yoderand and M W Witczak, Principles of Pavement Design, Wiley India Pvt. Ltd., New Delhi, 2012.
4. L J Pignataro, Traffic Engineering-Theory and Practice, Prentice Hall, New Jersey, 1973.
5. Relevant IRC and IS Codes of Practices.
    a) IS 5421-1981,
    b) IS 1498-1970(Reaffirmed 1997),
    c) IS:5421-1983 (Reaffirmed 1995),
    d) IS 2720 (Part4,5,6,7,8,10,11,13,16)
    e) IS 1498-1970(Reaffirmed 1977),
    f) IS 4332 (Part IV,V),
    g) IS 2386 (Part I, III, IV),
    h) IS 5640,
    i) IS 383,
    j) IS 6241,
    k) IS 1203,
    l) IS 73,
    m) IS 1202,
    n) IS 1205,

o) IS 1206 (Parts I,II,III),
p) IS 1208,
q) IS 8887,
r) IS 3117,
s) IS 217,
t) IS 1209,
u) IS 15462,
v) IRC 14, 15,17,23, 37,48, 58,94,
w) IRC SP 53,
x) AASHTO 283,
y) ASTM:D 2041-03a

5. Mapping of COs and POs

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

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

6. Mapping of COs and PSOs

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

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

CE 306 Water Resources Engineering

L	T	P	C
4	1	2	6

1. 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 different aspects of reservoirs.
CO5	Design important hydraulic structures.

2. Syllabus

- **INTRODUCTION TO WATER RESOURCES ENGINEERING (02 Hours)**
  Introduction, importance of water resources engineering, need of water resources projects.

- **PRECIPITATION AND ABSTRACTIONS (11 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 (09 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, synthetic unit hydrograph, IUH.

- **GROUND WATER HYDROLOGY (06 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 (08 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.

- **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.

- **RESERVOIR PLANNING AND SEDIMENTATION (07 Hours)**
  Types of reservoirs, investigations for reservoir planning, site selection, storage zones, yield, mass (07 Hours) inflow curve, determining capacity of reservoir, apportionment of total cost of a multipurpose reservoir, determination of life of reservoir, control of reservoir sedimentation, reservoir losses, flood routing.

- **HYDRAULIC STRUCTURES (10 Hours)**
  Necessity, location and types of dams, spillways, energy dissipation structures, canal falls, cross regulators, head regulators, canal escapes, canal outlets, cross drainage works. Important aspects of design of hydraulic structures.

(Total Lectures: 56 hours, Tutorials: 14 hours)

3. <u>Practicals</u>

1. Study of recording and non-recording rain gauges.
2. Study of pan evaporimeter.
3. Study of infiltrometers.
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 reservoir capacity.
10. Study of aspects of design of hydraulic structures

4. <u>Books Recommended</u>

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. <u>Mapping of COs and POs</u>

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

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

6. <u>Mapping of COs and PSOs</u>

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

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

CE 308 Design of Steel 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	Evaluate steel as building material, and composition of steel
CO2	Illustrate IS Codes, different loads and combination of loads, design philosophy
CO3	Analyze design philosophy for creating steel structure members (Design of tension, compression, flexure members) connection etc.
CO4	Apply knowledge for creating innovative steel structure and typical roof structure
CO5	Analyze the various industrial structures and design.

2. Syllabus

- **INTRODUCTION** **(04 Hours)**
  Steel as structural material, Eng. Structures, Philosophy of Design, Property of steel material specification, Limit state design.

- **LOADING** **(04 Hours)**
  Various load on structure, Load calculation, Load combination.

- **CONNECTIONS** **(08 Hours)**
  General Design consideration introduction to welded, Bolted connections semi rigid and rigid connection, Beam to beam and beam to column connection, moment resistant connection.

- **DESIGN OF STRUCTURAL MEMBERS** **(15 Hours)**
  Design of tension members - Design of compression members, built of compression members, -Design of flexural members-Design of slab base gusseted base foundation, Introduction to plate girder.- Introduction to plate girders.

- **INDUSTRIAL ROOF** **(05 Hours)**
  Analysis and design of typical industrial roof trusses with gantry girder.

- **INNOVATIVE STEEL STRUCTURES STUDY** **(06 Hours)**
  Design of steel foot over bridge.

(Total Lectures: 42 hours, Tutorials: 14 hours)

3. Practicals

1. Design of Industrial roof with the entire necessary infrastructure.
2. Drawing of Industrial roof with the entire necessary infrastructure.
3. Design and drawing of office steel multi-storeyed building.
4. Drawing of office steel multi-storeyed building

4. Books Recommended

1. N Subramanian, Steel Structure Design Practice, Oxford Press, Oxford, 2013.
2. S K Duggal, Design of Steel Structure, 2nd 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. Ramchandra and V. Gehlot, Design of Steel Structures, Seventh Edition, Standard Book House, New Delhi, 2017.

5. 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

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

6. 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 322 Sustainable Building Planning

L	T	P	C
3	0	0	3

---

1. Course Outcomes (COs)

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

CO1	Explain environmental impact on buildings and its assessment.
CO2	Interpret sustainable building planning policies for implementation.
CO3	Apply modern architecture, green building concept and global practices.
CO4	Apply modern eco-friendly material practices for national rating systems.
CO5	Explain energy conservation and its importance for urban sustainability.

2. Syllabus

- **SUSTAINABLE DEVELOPMENT AND PLANNING** **(04 Hours)**
  Concept, perspectives, need and importance, Environmental impact of building sector, current situation of environmental policies for building sector, concept and elements of sustainable planning for building industry, past perspectives on planning, situating sustainable planning within planning theory, Planners roles.

- **SUSTAINABLE BUILDING PLANNING** **(14 Hours)**
  Policies and exploring implementation gaps, urban design, Environment protection, site planning, energy conservation through planning and modeling, water use reduction, passive solar design, building technologies, indoor air quality, barriers to implementation of sustainable building measures, checklist for sustainability, policy recommendations for sustainable buildings. Innovative building material for rural and urban areas, Low Cost Infrastructure in rural Areas and Cost Cutting of housing Infrastructure.

- **URBAN HOUSING AND INFRASTRUCTURE** **(08 Hours)**
  Vernacular Architecture; Urban climate and effect of built environment, Impact of urbanization on sustainability, growth and issues related to sustainability.

- **GREEN BUILDINGS** **(06 Hours)**
  Concept and need, design principles, growth at International and national level, benefits, construction techniques, green materials, planning and case studies of residential, commercial and industrial buildings. Green building Evaluation Systems, LEED Certification, Green Globe Certification.

- **BUILDING PERFORMANCE ASSESSMENT** **(10 Hours)**

Concept, tools at international and national level, process of green building certification, comparison of different tools like LEED INDIA, GRIHA, IGBC, SB Tool etc. Recent researches on sustainable building development and assessment tools.

(Total Lectures: 42 hours)

3. Books Recommended

1. S M Wheeler, Planning for Sustainability: Creating Liveable, Equitable and Ecological Communities, Routledge, Taylor and Francis group, New York, 2004.
2. N Maiellaro, Towards sustainable building, Kluwer academic publishers, Netherlands, 2001.
3. Sustainable building design manual: Sustainable building design practices, The Energy and Resources Institute, New Delhi, 2009.
4. T Hasegawa, Environmentally sustainable buildings: challenges and policies, Organization for economic co-operation and development (OECD) publications, Paris, 2003.
5. T E Glavinich, Green Building Construction, Wiley, New Jersey, 2008.

4. Mapping of COs and POs

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

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

CE 324 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	Explain environmental impact on buildings and its assessment.
CO2	Interpret sustainable building planning policies for implementation.
CO3	Apply modern architecture, green building concept and global practices
CO4	Apply modern eco-friendly material practices for national rating systems.
CO5	Explain energy conservation and its importance for urban sustainability.

2. **Syllabus**

- **PLANNING OF RESIDENTIAL AREAS (15 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 (08 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, housing demand etc.

- **HOUSING POLICIES AND FINANCE (06 Hours)**
  Housing policies, Co-operative housing, Role of Central, State, Urban Local Bodies private and public sectors, financing institutes and their role, Housing Boards, HUDCO, NHB, HFIs, various international donor/financing agencies, micro finance institutions, rural housing finance, housing demand models.

- **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** **(05 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: 42 hours)

3. Books Recommended

1. A K Jain, Urban Housing and Slums, Read worthy Publication Pvt. Ltd., 2009.
2. Comprehensive General Development Control Regulations, Urban Development and Urban Housing Department, GoG, 2017.
3. G C Mathur, Low cost housing in developing countries, Oxford and JBH publishing Co. Private Ltd., 2014.
4. P Smets, Housing finance and the urban poor, Rawat publication, 2012.
5. Y S Sane, Planning and Designing of Building, Allies Book Stall, Poona 4, 1990.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 326 Pavement Analysis and Design

L	T	P	C
3	0	0	3

---

1. Course Outcomes (COs)

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

CO1	Identify key parameters to be considered for analysis and design of pavement
CO2	Analyse the pavement using various multi-layer theories
CO3	Design the pavement using various methods with different approaches
CO4	Design the overlay for existing pavement
CO5	Design the pavement using various methods with different approaches

2. Syllabus

- **FUNDAMENTALS OF PAVEMENT** **(05 Hours)**
  Types of pavement. Pavement composition and the function of each component. Factors governing design and analysis of pavement. Introduction to various approaches to design the pavement.

- **PAVEMENT ANALYSIS** **(12 Hours)**
  Stresses and strains in flexible and rigid pavement. Analysis of flexible pavement. Analysis of rigid pavement.

- **DESIGN OF FLEXIBLE PAVEMENT** **(09 Hours)**
  Design of flexible pavement as per guidelines given by IRC and AASHTO.

- **DESIGN OF RIGID PAVEMENT** **(10 Hours)**
  Design of rigid pavement as per guidelines given by IRC and AASHTO.

- **INTRODUCTION TO OVERLAY DESIGN** **(06 Hours)**
  Strengthening of flexible pavement by overlay - Flexible overlay, Rigid overlay. Strengthening of rigid pavement by overlay – Flexible overlay over rigid pavement, Rigid overlay over rigid pavement, Unbonded rigid overlay, Partially bonded rigid overlay.

(Total Lectures: 42 hours)

3. Books Recommended

1. L R Kadiyali and N B Lal, Principles and Practices in Highway Engineering (including Expressway and Airport Engineering), Khanna Publishers, New Delhi, 2017.
2. Y H Huang, Pavement Analysis and Design, Pearson Prentice Hall, New Delhi, 2013.
3. E J Yoder and M W Witczak, Principles of Pavement Design, Wiley India Pvt. Ltd., New Delhi, 2012.
4. R B Mallick and T El-Korchi, Pavement Engineering – Principles and Practice, CRC Press, Taylor and Francis Group, Boca Raton, Florida, 2013.
5. Relevant IRC and AASHTO Codes of Practices.

4. Mapping of COs and POs

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

- 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	3	3
CO5	3	3	3

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

CE 328 Transport Economics

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	Estimate road user cost and time value of money.
CO2	Perform economic analysis of a transportation project.
CO3	Evaluate alternate transportation project proposals.
CO4	Carryout life-cycle cost analysis of transportation projects.
CO5	Analyse the risk involved in financing a highway project.

2. Syllabus

- **INTRODUCTION TO TRANSPORTATION ECONOMICS (10 Hours)**
  Basic components of transport economics, review of engineering economics, elements of engineering economics, and microeconomics, principles of economic analysis, Depreciation and Inflation, Consumer and Social Surplus.

- **TRANSPORT COSTS AND BENEFITS (10 Hours)**
  Fixed and variable cost - Cost of improvement - Maintenance cost - Cost estimating methods- Pavement cost analysis - Direct benefits - Reduced vehicle operation costs - Value of travel time savings - Value of increased comfort and convenience - Cost of accident reduction - Reduction in maintenance cost.

- **ECONOMIC EVALUATION TECHNIQUES (12 Hours)**
  Generation and screening of project alternatives - Different methods of economic analysis: - Discounting and Non discounting criteria methods – NPV - IRR, Benefit/Cost analysis. Applicationeconomictheoryintrafficassignmentproblem-Breakevenanalysis, Road User Cost Study (RUCS) models for costs and benefits.

- **TRANSPORTATION PROJECT APPRAISALANDEVALUATION (10 Hours)**
  Feasibility and evaluation, cost, impacts and performance levels, evaluation of alternatives, analysis techniques, cost benefit analysis, social and financial benefits, prioritization of projects, multi-criteria decision assessment, Life Cycle Cost Analysis (LCCA) of different pavement types, Role of Highway Development and Maintenance (HDM) in feasibility studies.

- **INTRODUCTION TO OVERLAY DESIGN (06 Hours)**

Strengthening of flexible pavement by overlay - Flexible overlay, Rigid overlay. Strengthening of rigid pavement by overlay – Flexible overlay over rigid pavement, Rigid overlay over rigid pavement, Unbonded rigid overlay, Partially bonded rigid overlay.

(Total Lectures: 42 hours)

3. Books Recommended

1. J L Riggs, D D Bedworth and S U Randhawa, Engineering Economics, Tata McGraw Hill, Delhi, 2009.
2. S Mishra, Engineering Economics and Costing, 2nd Edition, Prentice Hall of India, New Delhi, 2010.
3. IRC: SP: 30-2009, Manual on Economic Evaluation of Highway Projects in India, Indian Roads Congress, New Delhi, 1993.
4. P K Sarkar and V Maitri, Economics in Highway and Transportation Planning, Standard Publisher, New Delhi,2010.
5. C G Swaminathan and L R Kadiyali, Road User Cost Study in India, Central Road Research Institute, New Delhi,1983.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 332 Groundwater Hydrology

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 the occurrence of ground water
CO2	Explain the principles of well hydraulics and computation of aquifer yield
CO3	Identify 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.

- **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** **(04 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** **(03 Hours)**
  Concept, interface and its location, control of intrusion.

- **TRANSPORT OF POLLUTANTS IN GROUND WATER** **(04 Hours)**
  Pollutant transport, Plume Transport, source identification, tracer methods.

(Total Lectures: 42 hours)

3. Books Recommended

1. D K Todd and L W Mays, Groundwater Hydrology, Third edition, John Wiley publishers, New York, 2011.
2. J Bear, Hydraulics of Groundwater, Dover Publications, 2007.
3. H M Raghunath, Groundwater and Well Hydraulics, Wiley Eastern Ltd, New Delhi, 1992.
4. A K Rastogi, Numerical Groundwater Hydrology, Penram International Publishing Mumbai, 2007.
5. F G Driscoll, Groundwater and Wells, Second edition, St. Paul, Minnesota, 1995.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 334 Channel Hydraulics

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

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

2. Syllabus

- **UNIFORM FLOW** **(06 Hours)**
  Specific energy, Specific energy curve and its limitations, critical depth and section factor for critical flow computations, open channel flow transitions, standing wave, venture flumes, control sections and hydraulic exponent for critical flow computations.

- **NON-UNIFORM FLOW** **(08 Hours)**
  Rapidly varied flow, specific force curve and its application in the analysis of hydraulic jump, hydraulic jump characteristics Assumptions in GVF analysis, dynamic equation of GVF, classification of channel slopes, GVF profiles, its identification and computation, applications.

- **SPATIALLY VARIED FLOW** **(08 Hours)**
  Basic principles and assumptions, differential equations, analysis of flow profiles and flow through side weirs and bottom racks.

- **UNSTEADY FLOW** **(06 Hours)**
  Waves, classification of waves, waves celerity, occurrences of unsteady flow, height and celerity of gravity waves, governing equations for one dimensional flow, St. Vennant equation and numerical methods.

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

- **TWO-DIMENSIONAL FLOW** **(06 Hours)**

Governing equations, Mac Cormack scheme, Gabutti scheme, artificial viscosity, finite volume scheme, applications.

(Total Lectures: 42 hours)

3. Books Recommended

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

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 336 Advanced Surveying

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 advanced surveying techniques including EDM and Terrain Data Collection
CO2	Identify the techniques of triletration for establishment of Horizontal Control
CO3	Analyze the problem and its remedial measures pertaining to hydrographic Survey, curve setting and Trilateration.
CO4	Compute and detail Azimuth, Declination etc. of celestial bodies using principle of astronomy.
CO5	Utilize the theory of error with measured quantities in surveying

2. Syllabus

- **ELECTRONICS DISTANCE MEASUREMENT** **(06 Hours)**
  Introduction, Electromagnetic Waves, Basic Definitions, Phase and Types of Waves, Distance Measurement by Transit time and by Phase difference, Electro-optical, Infrared and Microwave EDM Instrument, Slope and Height Corrections.

- **TERRAIN DATA COLLECTION** **(06 Hours)**
  Airborne laser thematic mapper (ALTM), LIDAR, Profiles, Digital Elevation Models.

- **TRILATERATION** **(06 Hours)**
  Introduction, use of triletration, Advantages and Disadvantages of Triletration, Comparison of Triletration with Triangulation, Reconnaissance, Geometrical Figures and Precision in Triletration, Adjustment of Triletration.

- **HYDROGRAPHIC SURVEYS** **(06 Hours)**
  Objects, Applications, Establishing controls, Shore line survey, Sounding, Sounding equipment, Methods of locating soundings, conventional and using GPS, Reduction of soundings, Plotting of soundings, Nautical sextant and its use, Three point problem and its use, solution of three point problem by all methods, Tides and tide gauges, determination of MSL.

- **SETTING OUT CURVE** **(07 Hours)**
  Introduction, classification of curves, Definition and Notations, Simple Circular Curves, Methods of Setting out Curves, Compound Curve, Transition Curves, Vertical Curves.

- **PRINCIPLES OF FIELD ASTRONOMY** **(05 Hours)**
  Introduction, purposes, astronomical terms, determination of azimuth, latitude, longitude and time corrections to the observations.

- **THEORY OF ERRORS** **(06 Hours)**
  Introduction, types of errors, definitions, laws of accidental errors, laws of weights, theory of least squares, rules for giving weights and distribution of errors to the field observations, determination of the most probable values of quantities.

(Total Lectures: 42 hours)

3. Books Recommended

1. K R Arora, Surveying and Levelling, Vol. III, Standard Publications, Delhi, 2000.
2. T P Kanitkar and S V Kulkarni, Surveying and Levelling, Vol. III, Vidyarthi Gruh Prakashan, Pune, 1995.
3. R Subramanian, Surveying and Leveling, Oxford University Press, New Delhi
4. J M Anderson and A M Mikhail, "Surveying theory and practice" 7th Edition by Tata McGraw Hill, New Delhi, 2012.
5. B C Punmia, Surveying and Levelling, Vol. II & III, Laxmi Publications Pvt. Ltd., New Delhi, 2006.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 338 Environmental Ethics, Law and Policy

L	T	P	C
3	0	0	3

1. **Course Outcomes (COs)**

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

CO1	Analyse local and global environmental impact issues.
CO2	Explain the significance of environmental ethics in today scenario
CO3	Analyse different national environmental policy and guidelines.
CO4	Explain the concepts of environmental auditing, monitoring and reporting.
CO5	Evaluate important Indian and global environmental protection acts and protocols.

2. **Syllabus**

- **CURRENT PERSPECTIVES OF ENVIRONMENTAL PROTECTION (06 Hours)**
  Present perspectives on practical environmental issues; Current practices of environmental solutions through engineering, technology, legislation etc; Need for environmental ethics in today's scenario; Introduction to Environmental Ethics; Pollution - the scientific vs. philosophical view.

- **ENVIRONMENTAL MANAGEMENT (09 Hours)**
  Moral Psychology, the environment and ethics; Religious and cultural views; ethics and law; Important Indian environmental legislation and acts such as Water Act-1974, Air Act-1981; Important rules under Environment Protection Act (EPA) – 1986 such as Biomedical Waste Rules-1998, EIA Rules-1994, Coastal Regulation Zone-1999, Municipal Solid waste rules, Hazardous Waste Rules-2008 etc.

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

- **INTERNATIONAL ISSUES AND ETHICS AND LAWS (12 Hours)**
  Solution of international global and local issues through environmental ethics; Ethics & Social Responsibility; Global Ecology and the Shadow of Development; The Global Ecological Crisis; Holistic Environmental Ethics; Towards Global Justice and Planetary Health International environmental laws and protocols such as Stockholm Conference, Montreal Protocol, Rio Earth Summit, Kyoto Summit; Role of UN authorities in protection

of global environment; Global environmental issues and environmental laws to control global warming, ozone depletion, acid rain, hazardous waste.

- **ENVIRONMENTAL POLICY** **(06 Hours)**
  National Environmental policy; environmental guidelines and regulations; environmental auditing, monitoring and reporting, environmental labeling studies by Central / State bodies; theory of corporate strategies; beyond environmentalism and sustainability issues.

(Total Lectures: 42 hours)

3. Books Recommended

1. G Singh, Environmental law in India, Macmillan India, New Delhi, 2005.
2. K Thakur, Environmental protection law and policy in India, Deep and Deep publishers, New Delhi, 1997.
3. Relevant MoEF Notifications and CPCB / GPCB Acts & Rules.
4. H Rolston, A New Environmental Ethics: The Next Millennium for Life on Earth, Routledge, London, 2011.
5. P Pojman and L P Pojman, Environmental Ethics, Cengage Learning, New York, 2011.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 342 Construction Safety 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	Assess construction safety performance
CO2	Apply knowledge of accident theories to prevent accidents
CO3	Analyze technologies, standards and acts for construction safety.
CO4	Design and audit for safety management system
CO5	Develop safe working environment in construction

2. Syllabus

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

- **PREVENTION OF ACCIDENTS (08 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 (08 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 (08 Hours)**
  Construction safety related acts and rules (central act, central and state rules), building & other construction workers (BOCW) act, 1996 and central rules, 1998, 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 (R&A) 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: 42 hours)

3. Books Recommended

1. R E Levitt and N M Samelson, Construction Safety Management, John Wiley & Sons, New York, 1993.
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	2	3	1	1	1	3	3	1	1	1	1	2
CO3	1	2	1	1	1	3	3	3	1	1	1	3
CO4	3	1	2	1	3	3	3	3	3	2	2	2
CO5	1	1	2	1	3	3	3	1	1	1	1	2

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

5. Mapping of COs and PSOs

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

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

CE 362 Environmental Health and Risk 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 the significance of health and hygiene
CO2	Describe health issues related with occupational and societal factor.
CO3	Correlate epidemiology with environmental exposures and diseases.
CO4	Integrate health and sanitation approach.
CO5	Design risk management tools and program.

2. Syllabus

- **INTRODUCTION (12 Hours)**
  Dimensions of environmental health – Causative agents of diseases – Social factors – Urban problems – Housing and health – Economy and health – Climate and other atmospheric elements – Violence – Chronic and communicable diseases – Occupational health – Epidemiological data – Occupational health hazards – Environmental exposure and diseases – industrial toxicants – Ergonomics – Controlling stress of life.

- **ASSESSMENT OF ENVIRONMENTAL HEALTH (08 Hours)**
  Epidemiology – Out break Epidemiology –Disease control – disease prevention – morbidity and mortality – Foodborne and waterborne diseases outbreaks – Integrated Approach to Health and Sanitation.

- **ELEMENTS OF ENVIRONMENTAL RISK ASSESSMENT (10 Hours)**
  Hazard identification and accounting – Fate and Behaviour of toxics and persistent substances in the environment – Receptor exposure to Environmental Contaminants – Dose Response Evaluation – Exposure Assessment – Exposure Factors, Slope Factors – Dose Response calculations and Dose Conversion Factors – Risk Characterization and consequence determination – Vulnerability assessment – Uncertainty analysis – Event tree and fault tree modelling and analysis

- **TOOLS FOR RISK MANAGEMENT (12 Hours)**
  HAZOP and FEMA methods – Risk communication and Risk Perception – comparative risks – Risk based decision making – Risk based environmental standard setting – Design

of risk management programs – Case studies on risk assessment and management programme

(Total Lectures: 42 hours)

3. Books Recommended

1. J X Kasperson and R E Kasperson, Global Environmental Risks, V N University Press, New York, 2003.
2. S L Cutter, Environmental Risks and Hazards, Prentice Hall of India, New Delhi, 1999.
3. J F Louvar and B D Louver, Health and Environmental Risk Analysis Fundamentals with applications, Prentice Hall, New Jersey, 2007.
4. A Ramaswami, A Milford and J B Small, Integrated Environmental Modelling – Pollutant Transport, Fate, and Risk in the Environment , John Wiley & Sons, New Jersey, 2005.
5. B Taylor, Effective Environmental, Health, and Safety Management Using the Team Approach, Culinary and Hospitality Industry Publications Services, New York, 2005.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 364 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** **(12 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: 42 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 366 Smart Cities Planning and Management

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	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** **(08 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: 42 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	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	2	2	3	3	3	3

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

5. 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

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

CE 368 Climate Change Studies

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 basics of weather, climate, climate variability, climate change and its impact
CO2	Explain 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	Explain the extreme climate events and modelling of climate change
CO4	Apply statistical methods in hydro-climatology
CO5	Outline observed and projected impacts, vulnerability and adaptation for Asia

2. Syllabus

- **INTRODUCTION** **(05 Hours)**
  Greenhouse effect. Weather. Climate. Climate variability. ENSO, IOD and climate change. Impacts of climate change.

- **FUNDAMENTALS OF CLIMATE CHANGE STUDY** **(08 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. Droughts. Drought indicators. Heat waves. Climate extremes.

- **CLIMATE CHANGE** **(05 Hours)**
  Introduction. Causes of climate change. Modelling of climate change. General circulation models. IPCC scenarios.

- **STATISTICAL METHODS IN HYDRO-CLIMATOLOGY** **(07 Hours)**
  Trend analysis. Empirical orthogonal functions. Principal component analysis. Canonical correlation. Downscaling and statistical downscaling with regression.

- **OBSERVED AND PROJECTED IMPACTS, VULNERABILITY AND ADAPTATION FOR ASIA** **(06 Hours)**

Sub-region diversity. Observed impacts. Projected impacts. Vulnerability to key drivers and adaptation options for freshwater resources. Terrestrial and inland water systems. Coastal systems and low lying areas. Food production systems and food security. Human settlements. Industry and infrastructure and human health. Security. Livelihoods and poverty. Economics of climate change.

(Total Lectures: 42 hours)

3. Books Recommended

1. G B Bonan, Ecological Climatology, Cambridge University Press, Cambridge, 2002.
2. G G Campbell and J M Norman, An Introduction to Environmental Biophysics, Springer Verlag, New York, 1998.
3. H V Storch and A Navarra, Analysis of Climate Variability, 2nd Edition, Springer-Verlag, Berlin Heidelberg, 1995.
4. V Storch and F W Zwiers, Statistical Analysis in Climatic Research, Cambridge, 1999.
5. P P Mujumdar and D N Kumar, Floods in a Changing Climate: Hydrologic Modeling, Cambridge University Press, Cambridge, 2012.

4. Mapping of COs and POs

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

0-Not related 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	3	1	2
CO5	2	1	2

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

CE 372 Intelligent Transportation Systems

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 various components of Intelligent Transportation Systems (ITS) and supporting technologies
CO2	State the role of ITS and its applications for improving the performance of the transportation system.
CO3	Construct ITS related strategies for varying roadway and traffic conditions using design and control parameters.
CO4	Describe ITS related strategies for improving the sustainability, efficiency and safety of transportation system.
CO5	Evaluate effectiveness of measures for improving traffic safety and efficiency.

2. Syllabus

- **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)** **(02 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** **(04 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). Case studies.

(Total Lectures: 42 hours)

3. <u>Books Recommended</u>

1. S Ghosh and T Lee, Intelligent Transportation Systems, CRC Press, Boca Raton, 2010.
2. C Drane and C R Drane, Positioning Systems in Intelligent Transportation Systems, Artech House Publishers, London, 1997.
3. J M C Queen and B McQueen, Intelligent Transportation System and Architecture, Artech House Publishers, Artech House, London, 1999.
4. A J Khattak, Intelligent Transportation Systems: Planning, Operations, and Evaluation, CRC Press, United Sates, 2014.
5. M A Chowdhury and A Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House, London, 2010.

4. <u>Mapping of COs and POs</u>

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

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

5. <u>Mapping of COs and PSOs</u>

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

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

CE 374 Water Infrastructure in Smart Cities

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 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** **(07 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** **(08 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 Lectures: 42 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

0-Not related 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

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

CE 376 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)**
  Water requirement, water availability, water budget, water balance, Zero liquid discharge concept and implementation.

- **INCINERATION AND GASIFICATION** **(10 Hours)**
  Life cycle cost of distribution network, design and analysis of water distribution network.

- **PYROLYSIS, GAS PURIFICATION** **(08 Hours)**
  Design of sewerage network, Design of effluent collection network.

- **ANAEROBIC PROCESSES** **(08 Hours)**
  Selection of IDF, Design of Storm water network with innovation, Flood plain delineation, integrated flood management practice.

- **ALGAL BIOMASS FROM WASTEWATER AND ENERGY PRODUCTION** **(06 Hours)**
  Human-machine interface, wireless sensors, remote monitoring solution, SCADA.

(Total Lectures: 42 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 378 Disaster Management

L	T	P	C
3	0	0	3

---

1. Course Outcomes (COs)

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

CO1	Identify the various features of natural and manmade disaster and safety measures for them.
CO2	Formulate the structure of disaster management (NDMA and GSDMA).
CO3	Design mitigation preparedness, early warning system for various disasters.
CO4	Evaluate disaster management plan for any system.
CO5	Explain various disaster plan and apply the knowledge in field.

2. Syllabus

- **TYPES OF DISASTERS** **(07 Hours)**
  Its dimensions – Impact of Disasters – Forecasting – Role of Remote Sensing and Geographical Information System in Disaster management – Vulnerability.

- **DISASTER REDUCTION STRATEGIES** **(07 Hours)**
  Multi Hazard Mapping– Losses from Global Disaster s and Expenses in Reconstruction and Retrofitting of structures.

- **ROLE OF NGO, GOVERNMENT BODIES** **(06 Hours)**
  Public, Social and Economic Development of Disaster-Prone areas – Emergency Planning.

- **STRUCTURE OF DISASTER MANAGEMENT IN INDIA** **(10 Hours)**
  NDM and Surat Disaster Management.

- **DISASTER MANAGEMENT** **(10 Hours)**
  Process and Mainstreaming.

- **VARIOUS CASE STUDIES** **(02 Hours)**
  Examples of cyclone disaster management, Fire Disaster Management, Industrial disaster management, medical disaster management and earthquake disaster management.

(Total Lectures: 42 hours)

3. Books Recommended

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

4. Mapping of COs and POs

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

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

5. 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 382 Advanced Mechanics of Solids

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	Annotate the fundamental properties of various materials.
CO2	Analyse the problems related to structural members subjected to tension, compression, torsion and bending using fundamental concepts of stress and strain.
CO3	Implement concepts of failure theories for designing structural members.
CO4	Derive the relations between stress and strain for structural members.
CO5	Analyse the beam by various theories on elastic foundation.

2. Syllabus

- **INTRODUCTION** **(03 Hours)**
  Review of basic concepts and equations in mechanics, Classification of materials, Outline of general techniques to solve boundary value problems.

- **KINEMATICS** **(04 Hours)**
  Seismic Geography and tectonic features of India – Seismic zones earthquake in India.

- **EQUILIBRIUM EQUATIONS** **(04 Hours)**
  Derive equilibrium equations in Cartesian and cylindrical polar coordinates.

- **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.

- **BOUNDARY VALUE PROBLEMS** **(04 Hours)**
  Formulation, Displacement method, Stress method, Airy's stress functions for plane stress and strain problems, Uniaxial Tension, Thick-walled annular cylinder subjected to uniform boundary ure, Infinite medium with a stress free hole under far field tension loading.

- **BENDING OF PRISMATIC STRAIGHT BEAMS** **(05 Hours)**

Pure bending, bending due to uniform transverse loading and bending due to transverse sinusoidal loading of a beam, Asymmetrical bending of straight beams, Shear center, Shear stresses in thin walled open sections.

- **END TORSION OF PRISMATIC BEAMS** **(06 Hours)**
  Formulation of the BVP for torsion of beams with solid cross section - warping function and Prandtl stress function approach, Torsion of circular, elliptic, rectangular and triangular cross sections, Membrane analogy, Torsion of thin walled tubes, thin rectangular sections, rolled sections and multiply connected sections.

- **BENDING OF CURVED BEAMS** **(06 Hours)**
  Winkler-Bach Formula, Elasticity solution for: pure bending of curved beams, curved cantilever under end loading.

- **BEAM ON ELASTIC FOUNDATION** **(06 Hours)**
  Derivation of the basic governing equation, Solution to beam on an elastic foundation subjected to a point load at the center, moment at the center, uniformly distributed load over some length 'a' symmetrically about the center.

(Total Lectures: 42 hours)

3. Books Recommended

1. L S Srinath, Advanced Mechanics of Solids, Tata McGraw-Hill, New Delhi, 2007.
2. A R Ragab and S E Bayoumi, Engineering Solid Mechanics: Fundamentals and Applications, CRC Press, New York, 1999.
3. M H Sadd, Elasticity: Theory, Applications and Numerics, Academic Press, London, 2006.
4. R S Khurmi, Strength of Material, S. Chand Publication, New Delhi, 2006.
5. S P Timoshenko, History of Strength of Materials, Dover Publications Inc, New York, 1983.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

SEMESTER VII

CE 401 Heavy Construction and Project Management

L	T	P	C
3	1	0	4

7. Course Outcomes (COs)

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

CO1	Apply project management fundamentals for managing heavy construction projects
CO2	Demonstrate construction planning, scheduling and controlling
CO3	Illustrate construction methods (techniques) for heavy construction
CO4	Demonstrate advanced project management tools and techniques
CO5	Assess project financial appraisals and advance management techniques

8. Syllabus

- **CONSTRUCTION PROJECTS** **(04 Hours)**
  Concept of project and its features, characteristics of construction projects, construction project management practice, organization of construction project, project categories, project planning & organization systems, heavy construction projects, project success strategies, construction industry in India.

- **HEAVY CONSTRUCTION EQUIPMENTS** **(08 Hours)**
  Classification of construction equipment, types & characteristics of heavy construction equipment, equipment capacities & costs, machine power, dozers, scrapers, excavators, trucks & hauling equipment, draglines & clamshells, pile driving equipment, selection of equipment, acquisition of equipment, time value of money for heavy construction equipment.

- **CONSTRUCTION OF HEAVY FOUNDATIONS** **(08 Hours)**
  Fundamentals theories of heavy foundations, deep foundation theories, design concepts of deep foundation, types of heavy foundations, pile foundation, caissons, coffer dams and raft foundation, construction techniques of heavy foundation, safety during construction of heavy foundation, resource planning for heavy foundation construction

- **PROJECT MANAGEMENT** **(14 Hours)**
  Work scope planning, project work breakdown structures, bar charts, network analysis fundamentals, network elements, network development, CPM network development and analysis, PERT, CPM vs. pert, precedence network analysis fundamentals, line of balance,

network updating, resource allocation and scheduling fundamentals, leveling & smoothing, time–cost analysis, quality control methods, construction safety, disputes and resolution techniques

- **PROJECT FINANCE AND APPRAISAL** **(04 Hours)**
  Need & types of project appraisals, concepts of financial appraisal, finance source for heavy construction projects, methods of financing the heavy construction projects, major financing bodies, economic evaluation of project, Indian practice of investment appraisal, time value of money, analysis of risk, discounted and non-discounted cash flow methods

- **ADVANCED PROJECT MANAGEMENT** **(04 Hours)**
  Project management information systems, it applications in project management, project document management, cloud computing, cloud economics, project management software, web based construction project management, building information modelling (BIM) for construction project management

(Total Lectures: 42 hours , Tutorials: 14 hours)

9. Books Recommended

6. K N Jha, Construction Project Management: Theory and Practice, Pearson Education, New Delhi, 2015.
7. K K Chitkara, Construction Project Management: Planning, Scheduling & Controlling, 3rd Edition, Tata McGraw - Hill Publishing Co. Ltd., New Delhi, 2014.
8. P Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation, and Review, Tata McGraw-Hill, New Delhi, 2009.
9. R L Peurifoy, Construction Planning, Equipment, and Methods, Tata McGraw-Hill, New Delhi, 2002.
10. F Harris and R McCaffer, Modern Construction Management, Seventh Edition, Blackwell Publishers, Oxford, 2013.

10. Mapping of COs and POs

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

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

11. Mapping of COs and PSOs

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

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

CE 403 Design of Concrete Structures

L	T	P	C
3	1	2	4

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** **(11 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** **(05 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** **(03 Hours)**
  Types of staircase – 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: 42 hours, Tutorials: 14 hours, Practicals: 14 hours)

3. Practical

11. Design of rectangular, T, L beam of Singly / Doubly Reinforced types.
12. Design of one way simply supported slab.
13. Design of two-way simply supported slab.
14. Design of one-way continuous slab.
15. Design of two-way continuous slab for different boundary conditions.
16. Design of footing
17. Design of Stair case
18. Application of Structural analysis and design software.

4. Books Recommended

1. S U Pillai and D Menon, Reinforced Concrete Design, 3rd edition, Tata Mc Graw Hill Publication Ltd, New Delhi. 2009.
2. S N Sinha, Reinforced Concrete Design, 2nd edition, Tata Mc Graw Hill Publishing Co., Ltd, New Delhi, 2006.
3. H J Shah, Reinforced Concrete, Vol-I 6th Edition, Charotar Publishing House, Anand, 2007.
4. M L Gambhir, Fundamentals of Reinforced Concrete Design, Prentice Hall of India, New Delhi, 2006
5. N Subramanian, Design of Reinforced Concrete Structures, Oxford University Press, New Delhi, 2013.

5. 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

6. 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

CE 421 Urban Infrastructure Planning and Management

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Explain urban infrastructure needs and provision techniques
CO2	Interpret urban infrastructure norms and guidelines
CO3	Analyse field situation for implementable solutions
CO4	Apply modern maintenance and management techniques
CO5	Explain different models for infrastructure provision

2. Syllabus

- **URBAN INFRASTRUCTURE PLANNING** **(04 Hours)**
  Data required for provision & planning of urban Infrastructure, Types, significance, impact on urban form, norms and financial aspects, public private, SPV and PPP models in infrastructure provisions, infrastructure policy.

- **NETWORKS AND SERVICES SYSTEMS** **(10 Hours)**
  Urban services overview, classification and significance, Concepts and theories for design and operation, components, interrelationship, requirements of appropriate technology, cost recovery, Gap analysis.

- **WATER SUPPLY NETWORK** **(08 Hours)**
  City and Household Network Scenario, Norms, National water policy, Water rights: excess and underutilization of water, role of community in water provision, water harvesting, privatization of water supply and its implications

- **SEWERAGE NETWORK** **(04 Hours)**
  City and Household Network Scenario, Norms. Sewerage drainage, refuse collection, storage, recycling and disposal, minimum basic needs, formulation of objectives, norms and standards both for space allocation and quality control, Storm water Network.

- **SANITATION AND SOLID WASTE MANAGEMENT** **(04 Hours)**
  Types, Generation, collection system, transfer station location, Segregation, transportation, disposal, site selection, Effect of population density, Impact of Urban land use, Bio-medical waste and disposal, Policies and programs in the provision of sanitation at various

level, Low Cost Sanitation, city sanitation plan and state sanitation strategies, cost recovery in solid waste

- **ELECTRICITY AND COMMUNICATION NETWORK** **(04 Hours)**
  Location, transformer, station, street lighting requirements, telecommunication network requirement

- **SOCIAL INFRASTRUCTURE** **(08 Hours)**
  Health and Education hierarchy, norms and location. Energy distribution, fire protection: requirements, norms and standards, planning provision, milk distribution system, Recreation & Open Space planning in Social Infrastructure

(Total Lectures: 42 hours)

3. Books Recommended

1. T M V Kumar, Networks and services, ITPI Reading Manuals, 2009.
2. TCPO and Ministry of Works and Housing, Norms and Standards for Urban Water Supply and Sewerage Services, New Delhi, 2017.
3. National Institute of Urban Affairs, Status of water supply, sanitation and solid waste management in urban area, New Delhi, 2005.
4. T Yigitcanlar, Sustainable urban and regional infrastructure development: technologies, application and management, IGI Global publishing company, New York, 2010.
5. CPHEEO, CPHEEO Manuals on water supply, sewerage, drainage and solid waste management, MoH and UA, GoI, New Delhi, 2019.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 423 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	Explain significance of Urban Land Scenario in national perspective
CO2	Postulate dynamics of Urban Land market
CO3	Interpret land management techniques used in practice
CO4	Study land policies adopted at various levels
CO5	Study legal aspects for urban land development

2. Syllabus

- **LAND MARKET DYNAMICS** **(10 Hours)**
  Data required for provision & planning of urban Infrastructure, Types, significance, impact on urban form, norms and financial aspects, public private, SPV and PPP models in infrastructure provisions, infrastructure policy.

- **LAND ECONOMICS** **(10 Hours)**
  Urban services overview, classification and significance, Concepts and theories for design and operation, components, interrelationship, requirements of appropriate technology, cost recovery, Gap analysis.

- **LAND POLICIES AND PRACTICES AND TECHNIQUES** **(14 Hours)**
  City and Household Network Scenario, Norms, National water policy, Water rights: excess and underutilization of water, role of community in water provision, water harvesting, privatization of water supply and its implications

- **LEGAL ASPECTS** **(08 Hours)**
  City and Household Network Scenario, Norms. Sewerage drainage, refuse collection, storage, recycling and disposal, minimum basic needs, formulation of objectives, norms and standards both for space allocation and quality control, Storm water Network.

(Total Lectures: 42 hours)

3. Books Recommended

1. J Randolph, Environmental Land use planning and Management, Island Press, 2009.
2. P R Berke, Urban Land use Planning, University of Illinois Press, Illinois, 2009.
3. S V Lall, Urban Land Markets: Improving Land Management for Successful Urbanization, Springer, New York, 2009.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 425 Urban Transport System 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	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

2. Syllabus

- **URBANISATION PROCESS** **(04 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** **(04 Hours)**
  Urban system components - Urban spatial structure – Accessibility - Location theory - Land use models - Land use transport models, Lowry & Garin – Lowry models

- **URBAN PUBLIC TRANSPORTATION** **(04 Hours)**
  Urban growth and public transport needs - transit mode classifications - transit characteristics - fleet size and capacity estimation, goods/logistic transportation.

(Total Lectures: 42 hours)

3. 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. M J Bruton, Introduction to Transportation Planning, Hutchinson of London, 1988.
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.

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

-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

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

CE 427 Flood Control and River Training Works

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Evaluate morphological variation in Alluvial Rivers
CO2	Predict local scour in Alluvial Rivers
CO3	Design river embankment, guide banks, groyens and revertment for Alluvial Rivers
CO4	Apply Geo-Synthetics and other material in river training works
CO5	Compare flood control methods.

2. Syllabus

- **MORPHOLOGY AND HYDRAULICS OF ALLUVIAL RIVER (10 Hours)**
  Alluvial streams and their hydraulic geometry, bed level variation of alluvial streams, variation in plan form of alluvial streams, Analytical models of river morphology, Numerical models for morphological studies, flood plain analysis, morphology of some Indian rivers.

- **FLOOD CONTROL AND ITS ASSESSMENT (12 Hours)**
  Types of Floods, Different methods of Flood control, Floods in major Indian river basins, Types and design of flood forecasting and protection systems, Comparison of levees with bypass channels and off stream storage, reservoir operation for flood control and management, flood damage estimation models.

- **RIVER TRAINING AND FLOOD PROTECTION WORK (20 Hours)**
  Guide lines for planning and design of river embankments (levees), planning, design, construction and maintenance of guide banks and groynes for alluvial rivers, Application of Geo-synthetics and other materials in river training works

(Total Lectures: 42 hours)

3. Books Recommended

1. V T Chow, R M David and W Mays Larry, Applied Hydrology, McGraw-Hill Book Company, New Delhi, 1988.
2. R J Garde and K G Ranga Raju , Mechanics of sediment transportation and alluvial streams problems, New age International (P) Limited, Publishers, New Delhi, 2000.
3. R J Garde , River Morphology, New Age International Publishers, New Delhi, 2006
4. W Mays Larry, Hydraulic Design Handbook, Mc Graw Hill Companies, New Delhi, 1999.
5. BIS 10751(1994), 12094 (2000), 12926 (1995), 8408 (1994).

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 429 Advanced Hydrologic Analysis and Design

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Analyse the trends in rainfall
CO2	Estimate evapotranspiration and infiltration.
CO3	Estimate flood of gauged and ungauged catchments.
CO4	Apply flood routing models in rivers and reservoirs.
CO5	Estimate discharge and design storm water drainage system.

2. Syllabus

- **PRECIPITATION AND EVAPOTRANSPIRATION (10 Hours)**
  Alluvial streams and their hydraulic geometry, bed level variation of alluvial streams, variation in plan form of alluvial streams, Analytical models of river morphology, Numerical models for morphological studies, flood plain analysis, morphology of some Indian rivers.

- **FLOW THROUGH UNSATURATED ZONE (10 Hours)**
  Types of Floods, Different methods of Flood control, Floods in major Indian river basins, Types and design of flood forecasting and protection systems, Comparison of levees with bypass channels and off stream storage, reservoir operation for flood control and management, flood damage estimation models.

- **FLOOD ESTIMATION METHODS- DETERMINISTIC APPROACHES(08 Hours)**
  Guide lines for planning and design of river embankments (levees), planning, design, construction and maintenance of guide banks and groynes for alluvial rivers, Application of Geo-synthetics and other materials in river training works

- **FLOOD ROUTING (06 Hours)**
  Types of Floods, Different methods of Flood control, Floods in major Indian river basins, Types and design of flood forecasting and protection systems, Comparison of levees with bypass channels and off stream storage, reservoir operation for flood control and management, flood damage estimation models.

- **HYDROLOGIC STATISTICS (08 Hours)**

Guide lines for planning and design of river embankments (levees), planning, design, construction and maintenance of guide banks and groynes for alluvial rivers, Application of Geo-synthetics and other materials in river training works

(Total Lectures: 42 hours)

3. Books Recommended

1. V T Chow, R M David and W Mays Larry, Applied Hydrology, McGraw-Hill Book Company, New Delhi, 1988.
2. K N Mutreja, Applied Hydrology, Tata McGraw-Hill Publishing company Ltd., New Delhi, 1990.
3. K Subramanya, Engineering Hydrolog, Third Edition - Tata McGraw-Hill Publishing company Ltd., New Delhi, 2012.
4. V P Singh., Elementary Hydrology, Prentice Hall, New Delhi,1992.
5. C S P Ojha, P Bhunya and P Berndtsson, Engineering Hydrology, Oxford University Press, Oxford, 2008.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 431 Advanced Fluid Mechanics

L	T	P	C
3	0	0	3

---

1. Course Outcomes (COs)

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

CO1	Identify the fluid flows and accordingly application of basic laws of fluid mechanics to solve real time problems
CO2	Analyse viscous flow and flow instability
CO3	Analyse boundary layer
CO4	Analyse turbulent flow
CO5	Evaluate unsteady flow in pipe

2. Syllabus

- **EQUATIONS GOVERNING FLUID FLOW** **(07 Hours)**
  Reynolds transport theorem, law of conservation of mass-continuity equation, law of conservation of momentum equation of motion, law of conservation of energy- energy equation.

- **POTENTIAL FLUID FLOW** **(07 Hours)**
  Standard flow pattern- uniform flow, source, irrotational vortex circulation, doublet, source and sink, vortex pair; source and vortex-spiral flow; source and uniform flow-flow past a half body; doublet and uniform flow-flow past a half body; source, sink and uniform flow-flow past a Rankine body; doublet and uniform flow-flow past cylinder, doublet; Doublet, vortex and uniform flow-flow past a cylinder with circulation; Magnus effect.

- **VISCOUS FLOW AND FLOW INSTABILITY** **(07 Hours)**
  Equation of motion – Navier-Stokes equation, Exact and approximate solutions of N-S equation, creeping motion, theory of instability of laminar flow- methods of small disturbance, stability analysis, Orr- Somerfield equation, solution of OSE equation- neutral stability curve, stages of transition from laminar to turbulent flow, factors affecting transition from laminar to turbulent flow

- **BOUNDARY LAYER THEORY** **(08 Hours)**
  Factors affecting growth of boundary layer, momentum thickness, displacement thickness, energy thickness, order of magnitude analysis, Prandtl's boundary layer equation, exact solution of laminar boundary layer equation for flow on a flat plate, von Karman momentum integral equation and its application in computation of boundary shear stress,

drag, local and average coefficients of friction for laminar and turbulent boundary layers, factors affecting separation of boundary layer and its control.

- **TURBULENT FLOW** **(07 Hours)**
  Characteristics of turbulent flow, types of turbulent flow, averaging procedure, Reynolds equation for turbulent flow from N-S equation, Prandtl's mixing length theory for two-dimensional parallel flows, Karman-Prandtl's universal velocity distribution, smooth and rough turbulent flow and their velocity distributions, Moody's diagram - friction factor and its variation with Reynolds number and relative roughness

- **UNSTEADY FLOW IN PIPE** **(06 Hours)**
  Water hammer, Rigid and elastic water column theories, methods of analysis

(Total Lectures: 42 hours)

3. Books Recommended

1. W R Fox and A T McDonald, Introduction to Fluid Mechanics, Wiley and Sons Inc., New York, 1998.
2. A K Jain, Fluid Mechanics, Khanna Publishers, New Delhi,2012
3. V L Streeter, K Bedford and E B Wylie, Fluid Mechanics, McGraw Hill Book Company Ltd., New York, 1998.
4. F M White, Fluid Mechanics, The McGraw Hill Companies, New Delhi, 2008.
5. V Gupta and S K Gupta, Fluid Mechanics and its Applications, New Age International Private Limited, New Delhi, 2015.

4. Mapping of COs and POs

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

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

CE 433 Stochastic Hydrology

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	Acquire a thorough understanding of stochastic hydrology and its applications
CO2	Explain basic concepts in the probability theory
CO3	Explain various types of time series analyses
CO4	Explain various types of stochastic models
CO5	Apply various types of time series analyses and stochastic models

2. Syllabus

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

- **FUNDAMENTALS OF STATISTICS** **(09 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** **(12 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** **(11 Hours)**

Examples related to fitting probability distributions. Trend analysis, Spectral analysis. Stochastic models in hydrologic forecasting.

(Total Lectures: 42 hours)

3. Books Recommended

1. N T Kottegoda, Stochastic Water Resources Technology, The Macmillan Press Ltd., London, 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, First East-West Press Edition, New Delhi, 1995.
5. R T Clarke, Mathematical Models in Hydrology, Food and Agriculture Organization, Geneva, 1973.

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	2	1	1
CO2	1	1	1	1	1	1	1	1	1	1	1	1
CO3	1	1	1	1	1	1	1	1	1	2	1	1
CO4	1	1	1	1	1	1	1	1	1	2	1	1
CO5	1	1	1	1	1	1	1	1	1	2	1	1

-Not related 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	1	1	1

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

CE 435 GPS and Applications

L	T	P	C
3	0	0	3

12. Course Outcomes (COs)

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

CO1	Describe GPS and geodesy
CO2	Explain different positioning modes
CO3	Analyze different errors
CO4	Integrate GPS with other technologies
CO5	Solve complex civil engineering applications using GPS

13. Syllabus

- **GLOBAL POSITIONING SYSTEM** **(06 Hours)**
  History - Segments of GPS system - GPS receivers and its components –GPS signals.

- **DATUM, COORDIANTE SYSTEMS AND MAP PROJECTIONS** **(06 Hours)**
  Geodesy - Earth surface - Datum – Co-ordinate systems - Projection systems.

- **POSITIONING MODES** **(06 Hours)**
  Absolute positioning - Relative positioning - Differential GPS –Real Time Kinematic GPS.

- **ERRORS AND CORRECTIONS** **(06 Hours)**
  Types of errors - Accuracy and precision - Basic statistical concept – Satellite Geometry.

- **GPS AND INFORMATION TECHNOLOGY** **(09 Hours)**
  GPS-GIS integration–Other types of integrations - GPS and Remote Sensing - Web based development - GPS software

- **APPLICATIONS OF GPS** **(09 Hours)**
  General applications - Engineering applications - Special applications - Innovative applications - 3D modelling- Case studies

(Total Lectures: 42 hours)

14. Books Recommended

11. N K Agrawal, Essentials of GPS, Spatial Network, Hydrabad, 2006.
12. A Leick, L Rapoport and D Tatarnikov, GPS Satellite Surveying, John Wiley and Sons, 2015.
13. M N Kulkarni, Proceedings of CEP Training Course on The Global Positioning System and its Applications, IIT Bombay, Mumbai, 2003.
14. A E Rabbany, Introduction to GPS, Artech House, Boston, 2002.
15. G S Rao, Global Navigation satellite Systems, Tata McGraw Hill, New Delhi, 2010.

15. Mapping of COs and POs

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

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

16. Mapping of COs and PSOs

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

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

CE 437 Industrial 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 industrial wastewater with its impact on environment
CO2	Analyse the quality and quantity of waste generated from by different industrial manufacturing processes
CO3	Analyse industrial pollution prevention by applying advance treatment
CO4	Analyse wastewater management by advance treatment system
CO5	Explain handling of different industrial wastewater with 3R concept

2. Syllabus

- **INTRODUCTION** **(10 Hours)**
  Sources of wastes – Industrial and domestic – Nature and characteristics of wastewater – Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater– Quality and quantity of industrial wastes –Evaluation of pollution prevention – physical, chemical and biological process. Prevention Vs Control of Industrial Pollution – Benefits and Barriers.

- **INDUSTRIAL POLLUTION PREVENTION** **(10 Hours)**
  Waste minimization – Source reduction Techniques – waste volume reduction- Waste strength reduction – Neutralization – Removal of suspended and colloidal solids – Removal of inorganic and dissolved solids – reduction of wastewater at point source.

- **ADVANCE WASTEWATER MANAGEMENT** **(10 Hours)**
  Waste Audit – Mass Balance - Toxicity of industrial effluents and Bioassay tests - Individual and common effluent treatment plants – Zero effluent discharge systems – Wastewater quality requirements for its reuse. Quantification and characteristics of Sludge – Thickening, conditioning, digestion, dewatering and sludge disposal.

- **CASESTUDIES** **(12 Hours)**
  Industrial manufacturing process description– source of wastewater-Wastewater, characteristics– effect of wastewater on receiving water and sewers –waste treatment flow sheet for Textiles, Tanneries, Pulp and paper, Pharmaceuticals, Sugar.

(Total Lectures: 42 hours)

3. Books Recommended

1. P G Smith and J S Scott, Dictionary of Water and Waste Management - Heinemann, Linacre House, Oxford 2005.
2. S N Barton, Industrial Waste: Management, Assessment and Environmental Issues; Nova Science Publishers, New York, 2016.
3. A D Patwardhan, Industrial Waste Water Treatment. PHI Learning, New Delhi, 2008.
4. N L Nemerow, Industrial Waste Treatment, Elsevier Butterworth- Heinemann, USA, 2007.
5. M N Rao and A K Datta, Waste Water Treatment, Oxford & IBH Publishing, New Delhi, 2017.

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	2	1	1	0	2	1
CO2	2	2	3	1	1	1	1	1	1	1	1	1
CO3	2	3	3	3	3	2	2	3	3	2	1	2
CO4	3	1	3	3	3	2	2	3	2	2	2	1
CO5	2	1	1	1	2	1	1	1	1	1	2	1

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

5. Mapping of COs and PSOs

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

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

CE 439 Building Maintenance

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Realize significance of building maintenance in national context.
CO2	Realize the effect on buildings through different components.
CO3	Analyse special materials through case studies.
CO4	Develop skills for rehabilitation of buildings.
CO5	Acquire expertise of rehabilitation of historical buildings.

2. Syllabus

- **PRINCIPLES OF MAINTENANCE** **(10 Hours)**
  Terminology of maintenance and repairs- Objective - Life expectancy of buildings – Property inspection and report – Maintenance budget estimate – Health and safety requirement in maintenance – Agencies Causing Deterioration - Preventive and corrective maintenance - Routine maintenance of buildings– Maintenance problem and root causes. Maintenance cost – Specifications for maintenance work.

- **MAINTENANCE OF BUILDINGS** **(10 Hours)**
  Effect of environmental elements on buildings – Effect of chemical agents on buildings and building materials – Damage by biological agents like plants, trees, algae, fungus, moss, insects etc . Damp proofing of existing area – Repair of water supply and sanitary system - Type of repair materials, characteristics – Common technique of building repair – Surface preparation – Specification of Maintenance work – Termite control – Type of fire – Fire Protection and its effect on building.

- **FAILURE AND REPAIR OF BUILDINGS** **(12 Hours)**
  Definitions of building failure – Functional, structural and aesthetical failures – Case studies – Methodology to investigate of failures in building – Diagnostic testing methods and equipment, Material test, NDT – Repair of cracks in concrete and masonry – grouting, grouting, etc. – Repair and maintenance of foundation, basement and DPC – The Efflorescence Triangle – Repair of building joints - protection - Repair and maintenance of RCC element.

- **REHABILITATION AND CONSERVATION** **(12 Hours)**

Analysis-Planning-Cost Estimates-Tender-Methods-construction Methods-Modern materials for repairs – Historical Building -Conservation movement – Materials and methods for conservation work – Case studies – Reliability Engineering Principle – Its application in selection if building system.

(Total Lectures: 42 hours)

3. Books Recommended

1. S M Johnson, Deterioration Maintenance & Repair of Buildings, McGraw Hill Pub, New York, 1990.
2. R N Raikar, Technology of Building Repairs, Raikar Pub., Bombay, 1994.
3. H J Eldridge, Common defects in Buildings, HMSO. Publishers, New York, 2006.
4. National Building Code, 2002.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 441 Environmental Health and Risk 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 the significance of health and hygiene
CO2	Describe health issues related with occupational and societal factor.
CO3	Correlate epidemiology with environmental exposures and diseases.
CO4	Integrate health and sanitation approach.
CO5	Design risk management tools and program.

2. Syllabus

- **INTRODUCTION** **(12 Hours)**
  Dimensions of environmental health – Causative agents of diseases – Social factors – Urban problems – Housing and health – Economy and health – Climate and other atmospheric elements – Violence – Chronic and communicable diseases – Occupational health – Epidemiological data – Occupational health hazards – Environmental exposure and diseases – industrial toxicants – Ergonomics – Controlling stress of life.

- **MAINTENANCE OF BUILDINGS** **(08 Hours)**
  Epidemiology – Out break Epidemiology –Disease control – disease prevention – morbidity and mortality – Foodborne and waterborne diseases outbreaks – Integrated Approach to Health and Sanitation.

- **ELEMENTS OF ENVIRONMENTAL RISK ASSESSMENT** **(10 Hours)**
  Hazard identification and accounting – Fate and Behaviour of toxics and persistent substances in the environment – Receptor exposure to Environmental Contaminants – Dose Response Evaluation – Exposure Assessment – Exposure Factors, Slope Factors – Dose Response calculations and Dose Conversion Factors – Risk Characterization and consequence determination – Vulnerability assessment – Uncertainty analysis – Event tree and fault tree modelling and analysis.

- **TOOLS FOR RISK MANAGEMENT** **(12 Hours)**

HAZOP and FEMA methods – Risk communication and Risk Perception – comparative risks – Risk based decision making – Risk based environmental standard setting – Design of risk management programs – Case studies on risk assessment and management programme.

(Total Lectures: 42 hours)

3. Books Recommended

1. J X Kasperson and R E Kasperson, Global Environmental Risks, V N University Press, New York, 2003.
2. S L Cutter, Environmental Risks and Hazards, Prentice Hall of India, New Delhi, 1999.
3. J F Louvar and B D Louver, Health and Environmental Risk Analysis Fundamentals with applications, Prentice Hall, New Jersey, 2007.
4. A Ramaswami, A Milford and J B Small, Integrated Environmental Modelling - Pollutant Transport, Fate, and Risk in the Environment, John Wiley and Sons, New Jersey, 2005.
5. B Taylor, Effective Environmental, Health, and Safety Management Using the Team Approach, Culinary and Hospitality Industry Publications Services, New York, 2005.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 443 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** **(12 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: 42 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, USA, 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

-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

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

CE 445 Traffic Engineering and Management

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

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

2. Syllabus

TRAFFIC CHARACTERISTICS (06 Hours)

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

- **TRAFFIC FLOW MEASUREMENTS (06 Hours)**

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

- **INTERSECTION DESIGN (08 Hours)**

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

- **ELEMENTS OF DESIGN AND REGULATIONS (10 Hours)**

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

- **TRAFFICSAFETY** **(04 Hours)**
  Principles and Practices – Safety along links - Safety at intersections. Road Safety Audit Countermeasures, evaluation of effectiveness of counter-measures– Road safety programmes.

(Total Lectures: 42 hours)

3. Books Recommended

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

4. Mapping of COs and PSOs

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

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

5. Mapping of COs and PSOs

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

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

CE 447 Design of Industrial Structures

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	Classify the various industrial structures considering the statutory requirements.
CO2	Establish co-relationship between the various design parameters and determine forces, analysis, and design of various components of industrial building and gable frames
CO3	Analyse and design Foot Over Bridge, towers, gantry girders and different cable roofs.
CO4	Design industrial foundation
CO5	Determine various design parameters for design of various foundation for Industrial structure

2. Syllabus

- **PLANNING OF INDUSTRIAL STRUCTURE (06 Hours)**
  Classification of industries and local regulations - Factors affecting planning - General Aspects - Civil Engineering Aspects - Light and Ventilation.

- **DESIGN OF INDUSTRIAL STRUCTURES (12 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 (08 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 forces

- **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, IS Requirement, Analysis, 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: 42 hours)

3. Books Recommended

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

4. Mapping of COs and PSOs

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

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

5. Mapping of COs and PSOs

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

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

CE 449 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** **(07 Hours)**
  Classification – General requirements – Dynamic parameters of Soil – Foundations for reciprocating and impact type machines – Vibration isolation.

- **PRELOADING AND SAND DRAIN** **(07 Hours)**
  Precompression – General considerations – Sand drains and its application – Prefabricated vertical drains.

- **EARTHQUAKE GEOTECHNIQUES** **(07 Hours)**
  Types – Seismic waves – Location of earthquake – Factors influencing ground motion – Liquefaction evaluation of liquefaction susceptibility.

(Total Lectures: 42 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 PSOs

	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

0-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

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

CE 451 Advanced Concrete Technology

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	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 hardened concrete properties
CO4	Analyse the various durability related problems in reinforced concrete and its mitigation
CO5	Evaluate strength properties of hardened concrete.

2. Syllabus

- **HYDRATION AND MICRO-STRUCTURE OF CEMENT (09 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** **(08 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 Lectures: 42 hours)

3. Books Recommended

1. P Kumar Metha and P J M Monterio, Concrete- Microstructures, Properties and Materials, Indian Edition, Indian Concrete Institute, Chennai, 1999.
2. P C Aitcin, High Performance Concrete, E&FN Spon, London, 1998.
3. A R Santhakumar, Concrete Technology, Oxford University Press, New Delhi, 2007.
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.

4. Mapping of COs and PSOs

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

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

5. 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

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

CE 453 Geosynthetics and Reinforced Soil Structures

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 principles of reinforced soil and its applications
CO2	Identify the types of Geosynthetics and their functions
CO3	Analyse the different engineering properties of Geosynthetic and recognize their applications for various civil engineering constructions
CO4	Design the mechanically stabilised earth wall as per the codal guidelines
CO5	Design the reinforced slope and footing

2. Syllabus

- **INTRODUCTION** **(03 Hours)**
  Historical background of reinforced soil, Principles of reinforced soil through Mohr circle analysis

- **DIFFERENT TYPES OF GEOSYNTHETICS** **(04 Hours)**
  Types of geosynthetics like geotextiles, geogrids, geonets, geocells, geo-composites, their manufacturing methods

- **TESTING METHODS FOR GEOSYNTHETICS** **(05 Hours)**
  Techniques for testing of different index properties, strength properties, Apparent Opening Size, In-plane and cross-plane permeability tests, assessment of construction induced damage, extrapolation of long-term strength properties from short term tests.

- **REINFORCED SOIL RETAINING WALLS** **(12 Hours)**
  Different types of walls like wrap-around walls, full-height panel walls, discrete-facing panel walls, modular block walls. Design methods as per BS-8006 and FHWA methods Construction methods for reinforced soil retaining walls.

- **REINFORCED SOIL SLOPES** **(08 Hours)**
  Basal reinforcement for construction on soft clay soils, construction of steep slopes with reinforcement layers on comptenet soils, Different slope stability analysis methods like planar wedge method, bi-linear wedge method, circular slip methods. Erosion control on slopes using geosynthetics.

- **APPLICATIONS IN FOUNDATIONS** **(05 Hours)**
  Binquet and Lee's approach for analysis of foundations with reinforcement layers.

- **PAVEMENT APPLICATION** **(05 Hours)**
  Geosynthetics for separation and reinforcement in flexible pavements, design by Giroud Noiray approach, reflection cracking and control using geosynthetics. Use of geosynthetics for construction of heavy container yards and raiway lines.

(Total Lectures: 42 hours)

3. Books Recommended

1. R M Koerner, Designing with Geosynthetics. Prentice Hall, New Jersey, 2012.
2. S Babu, An Introduction to Soil Reinforcement & Geosynthetics, Universities Press, India, 2005.
3. J N Mandal, Geosynthetics Engineering: In Theory and Practice, Research Publishing, Singapore, 2018.
4. SK Shukla, An Introduction to Geosynthetic Engineering, CRC Press, Leiden, 2017.
5. S K Shukla, Yin JH. Fundamentals of Geosynthetic Engineering, CRC Press, Leiden, 2006.

4. Mapping of COs and PSOs

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

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

5. Mapping of COs and PSOs

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

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

CE 455 Introduction to Finite Element Method

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 basic concepts of finite element (FE) analysis
CO2	Identify and select the suitable element and mesh configuration to obtain converged solution
CO3	Develop the element characteristic equation and generation of global equation
CO4	Create 1D, 2D and 3D FE models of practical problems
CO5	Applying the FE analysis on actual problem to determine induced displacements, forces, stresses and strains

2. Syllabus

- **INTRODUCTION** **(06 Hours)**
  Matrix algebra, Fundamentals of continuum mechanics, Stresses displacements and strains in soils, solids and structures, Constitutive relations.

- **ONE- AND TWO-DIMENSIONAL PROBLEMS** **(08 Hours)**
  Plane stress and strain, Interpolation functions, Shape functions (Lagrangian / Natural), Isoparametric elements – 1D and 2D, Numerical integration. Infinite elements, Joint elements, Assembly and Solution techniques, Convergence requirements, Patch test, Examples.

- **AXISYMMETRIC PROBLEMS** **(06 Hours)**
  Formulation and Examples

- **THREE-DIMENSIONAL PROBLEMS, CONSTITUTIVE MODELLING (08 Hours)**
  Formulation and Examples, Elastic, Elastic-plastic and Advanced constitutive models.

- **FINITE ELEMENTS IN CIVIL ENGINEERING** **(08 Hours)**
  Applications: Analysis of Shells, Trusses, Beams and Frames, Thin and thick plates, Dynamic considerations, In situ earth pressure, Construction and excavation sequences, Slope stability analysis (c-φ reduction), Seepage, Consolidation, Settlement analysis, Groundwater flow.

- **SOFTWARE BASED LEARNING** **(06 Hours)**
  Pre-processing and Post processing, Tutorials/Assignments, solving few examples using FE based software (StaadPro, SAP 2000, ABAQUS, PLAXIS, Geo Studio, etc.).

(Total Lectures: 42 hours)

3. Books Recommended

1. Zienkiewicz OC, Taylor RL and Zhu JZ, The Finite Element Method Its Basis and Fundamentals, Elsevier, Amsterdam, 2014.
2. Hutton DV, Fundamentals of Finite Element Analysis, McGraw-Hill, New Delhi, 2004.
3. Reddy JN, An Introduction to the Finite Element Method, McGraw-Hill, New Delhi, 2005.
4. Chandrupatla TR and Belegundu AD, Introduction to Finite Elements in Engineering, Pearson Education, New Jersey, 2011.
5. Logan DL, A First Course in the Finite Element Method, Cengage-Learning, New Delhi, 2007.

4. Mapping of COs and PSOs

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

0-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	2	2
CO4	3	3	3
CO5	3	3	3

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

CE 457 Rock Mechanics

L	T	P	C
3	0	0	3

---

1. Course Outcomes (COs)

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

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

2. Syllabus

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

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

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

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

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

- **INTACT AND ROCKMASS CLASSIFICATIONS** **(06 Hours)**
  Deere and Miller, Geological classification, ISRM, Terzaghi, RQD, RSR, RMR and Q classifications, Rating, Applications

- **FIELD TESTS** **(03 Hours)**
  Necessity, Requirements of in-situ tests, Plate load test, Pressure tunnel test, Bore hole test

- **IMPROVEMENT IN PROPERTIES OF ROCKMASS** **(03 Hours)**
  Necessity, Grouting, Rock bolting, Cable anchorage

(Total Lectures: 42 hours)

3. Books Recommended

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

4. Mapping of COs and PSOs

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

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

5. Mapping of COs and PSOs

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

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

CE 459 Design of Formwork

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	Classify the various type of Formwork, Formwork material, Formwork properties.
CO2	Establish the various design parameters and those parameters for design of formwork.
CO3	Analyse and design formwork for special structure
CO4	Design innovation structural formwork using innovative material and failure study
CO5	Analyse the design of form structure.

2. Syllabus

- **INTRODUCTION** **(05 Hours)**
  Introduction to Formwork as a Temporary Structure, Requirements, Selection, and Classification (Types) of Formwork - Formwork Materials, Shoring Towers, and Scaffolds

- **FORMWORK DESIGN** **(15 Hours)**
  Formwork Design Concepts - Conventional and Proprietary Foundation Formwork. - Conventional and Proprietary Wall Formwork - Conventional and Proprietary Column Formwork.

- **ADVANCE FORMWORK** **(14 Hours)**
  Slab and Beam Formwork - Formwork for Special Structures such as Shells, Domes, Folded Plates, Overhead Water Tanks, Natural Draft Cooling Tower, Nuclear Reactor, Tunnel, and Lift Shaft. Formwork for Bridge Structures, Cases in Failure of Temporary Support Structures of Bridges - Flying Formworks such as Table Forms, Tunnel Formwork System, Column Mounted Shoring System, Gang Forms - Slip form -Formwork for Precast Concrete

- **FORMWORK MANAGEMENT ISSUE AND FAILURE** **(08 Hours)**
  Pre-Award and Post –award Formwork Management Issues - Formwork Failure - Formwork Issues in Multi-Story Building Construction

(Total Lectures: 42 hours)

3. Books Recommended

1. K N Jha, Formwork for Concrete Structures, First Edition, McGraw Hill., New Delhi, 2012.
2. R L Peurifoy and G D Oberlender, Formwork for Concrete Structures, McGraw Hill, New York, 2011.
3. Robinson and J.R.,Piers, Abutments and Formwork for Bridges Crosby Lockwood & Son Ltd., New York, 1964.
4. C K Austin, Formwork to Concrete, 3rd Edition, George Godwin, 1978.
5. C E Moore, Concrete Form Construction Albany, N.Y.: Delmar Publishers, New York, 1977.

4. Mapping of COs and PSOs

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

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

5. Mapping of COs and PSOs

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

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

CE 422 Regional Planning

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Explain significance of region and planning needs.
CO2	Delineate geographical regions.
CO3	Explain basics of regional economics.
CO4	Analyze resources requirements for regional development.
CO5	Interpret regional development theories for balanced outcome

2. Syllabus

- **REGIONAL DYNAMICS** **(06 Hours)**
  Definition of Region, Typology, classifications and Delineation of regions. Growth of Mega and Metro Regions: Scale, Complexity and its impact on national and international scenario, convergence and divergence. Regional Economy, competitiveness among regions, backward and leading regions in development; Special Regions: SEZ, Agro Regions, Ecological regions, etc.

- **REGIONS IN INDIA AND ITS PLANNING** **(08 Hours)**
  Regions in Indian Context: Resource Regions, Corridors as regions, National, subnational and State as a region, macro, meso and micro regions in India. Role of resources in regional development, utilization of resources and environmental problems Sectoral and regional development and imbalances, multilevel planning, special area development plans. Balanced developed development national and state level planning mechanism. Resource regions in India.

- **CORE AND PERIPHERY IN A REGION IN INDIAN CONTEXT** **(08 Hours)**
  Core, Fringe and Periphery in a Region and its planning; Tools and techniques available for planning regions in India; Role of 73rd and 74th Constitution Amendment Acts in regional plan Preparation and implementation. Concept of District Planning.

- **DEMOGRAPHIC AND EMPLOYMENT FORECASTING** **(04 Hours)**
  Population forecasting, Linear & Exponential models, Employment classification

- **ELEMENTS OF MICRO AND MACRO ECONOMICS** **(04 Hours)**

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

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

- **TECHNIQUES AND GROWTH MODELS OF REGIONAL ANALYSIS (12 Hours)**
  Regional Analysis: Introduction to regional analysis, regional linear programming, regional input-output analysis, factor analysis, industrial location theory, spatial diffusion theory, gravity analysis. **Growth Models:** Concept of growth pole and growth foci, core-periphery concept, role of settlements in regional development, urbanization and regional development, input – output models, central place Theory Christaller Loseh.

(Total Lectures: 42 hours)

3. Books Recommended

1. J Glassion, Introduction to regional planning, Hutchinson and MIT Press, Cambridge, 1996.
2. J R Chaudhuri, An Introduction to Development and Regional Planning, Orient Longman Ltd, Kolkata, 2001.
3. K V Sundaram, Urban and Regional Planning in India, Vikas Publishers, New Delhi, 1978.
4. M Chand and U K Puri, Regional Planning in India, Allied Publishers, New Delhi, 2011.
5. R P Mishra, Regional Planning, Concept Publishing Co., New Delhi, 2002

4. Mapping of COs and PSOs

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

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

5. Mapping of COs and PSOs

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

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

CE 424 Real Estate 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 concept of real estate sector development
CO2	Analyse urban building industry in national perspective
CO3	Interpret urban land policy for effective implementation
CO4	Evaluate real estate management limitations and finding solutions
CO5	Explain modern concept of land value and rent

2. Syllabus

- **REAL ESTATE** **(08 Hours)**
  Terminology: Land Documentation, Land Revenue Records, Document Registration, City Survey Record, Land Registration Process, Property Card, Index concepts and characteristics; Urban real estate market problems, factors affecting real estate property, rights and interests; Contract law and real estate; Speculation in urban land; betterment and worsening.

- **REAL ESTATE PLANNING AND MANAGEMENT** **(08 Hours)**
  Real estate planning methods, constraints, environmental factors, schemes & finance, Government policies.

- **ECONOMICS AND LOCATION MODELLING** **(16 Hours)**
  Factors affecting different land uses such as residential, commercial, industrial, public and semi-public; Land value – Concept and factors affecting; Rent and modern theory of rent; Macro and Micro approaches of Location such as trade-off model and environment preference model.

- **URBAN LAND POLICY** **(10 Hours)**
  Contents, importance, objectives, measures, instruments for its implementation, direct Govt. action, legal and physical controls; Relationship between economic trends, land market and urban development. Modern Methods for Land Pooling; PPP method for Land Pooling; Issues and strategies for Land Management

(Total Lectures: 42 hours)

3. Books Recommended

1. B N Paul, Urban Land Economics, The McMillan Press, London, 1997.
2. B Singh, Urban Infrastructure and Real Estate Management, Surendra Publications, New Delhi, 2011.
3. W Lean, Aspects of Land use Planning, Gonthic Publications, New Jersey, 1982.

4. Mapping of COs and PSOs

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

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

5. Mapping of COs and PSOs

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

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

CE 426 Urban Design and Landscape 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	Explain sustainable urban design and landscape for quality of life
CO2	Describe functional design strategies and landscape planning
CO3	Analyse of planning parameter for CBD, Town Centre and area-based character
CO4	Explain Public Private Partnership practices for revenue generation
CO5	Describe global practices and implications

2. Syllabus

- **SCOPE AND OBJECTIVES OF URBAN DESIGN (04 Hours)**
  Its relation with 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 (02 Hours)**
  Campus planning, city centers, transportation corridors, residential neighbourhood, water fronts. Urban landscape in relation to topography.

- **DEVELOPMENT CONTORL GUIDELINES (02 Hours)**
  Zoning, Historical examples of urban design projects. Evaluation/ feasibility study of urban design projects.

- **OBJECTIVES AND SCOPE OF LANSCAPE PLANNING (10 Hours)**
  Behavioural issues in landscape design, principles and aesthetic theory in landscape design, Land from design and elements of geomorphology, hydrology, pedology, drainage in landscape planning. Spatial organization of selected cities, emphasizing landscape assessment. Site and resources inventory methods, analyses and appraisal, landscape suitability analysis, Plant characteristics and planting design, environmental factors in landscape planning

- **LANDSCAPE PLANNING (10 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 (08 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 (02 Hours)**
  Zoning, Historical examples of urban design projects. Evaluation/ feasibility study of urban design projects.

(Total Lectures: 42 hours)

3. Books Recommended

1. B Hackett, Landscape planning: an introduction to theory and practice, Oriel, London, 1971.
2. F R Steiner, The living landscape: an ecological approach to landscape planning, McGraw-Hill, New York, 1991.
3. I L McHarg, Design with nature, Wiley, New Jersey, 1992.
4. M Carmona, Public places – Urban spaces, Architectural press, New York, 2003.
5. T Turner, Landscape planning and environmental impact design, 2nd ed, UCL Press, 1998.

4. Mapping of COs and PSOs

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

0-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	2	2	1
CO5	3	1	1

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

CE 428 Tourism 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	Explain fundamentals of tourism planning and development
CO2	Describe concept, technique and scheme of tourism
CO3	Analyse tourism industry and national economic development
CO4	Apply sustainable techniques for tourism planning and development
CO5	Interpret global and national tourism policies and case studies

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 (16 Hours)**
  Natural resource assessment; Techniques of tourism potential analysis; Concept of Ecotourism, 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 (12 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 (04 Hours)**

Tourism policies at various levels. CASE STUDIES: Indian Site, Projects for Gujarat Tourism

(Total Lectures: 42 hours)

3. Books Recommended

1. C M Hall, Tourism Planning: Policies, Process & relationship, Prentice Hall, Singapore, 2008.
2. N David, Natural area tourism Ecology impacts and management, Chainal View Publication, 2008.
3. G Clare, Tourism Planning: Basics, Concepts, cases, France & Taylor Publication, London, 2009.
4. C R Goeldner, J R R Brent, Tourism: Principles, Practices, Philosophies, John Wiley & Sons, New jersey, 2009.
5. A Satishbabu, Tourism Development in India, APH Publishing Corporation, New Delhi, 2008.

4. Mapping of COs and PSOs

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

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

CE 432 Smart Cities Planning and Management

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Explain concept and global practices.
CO2	Study framework, practice codes and national mission.
CO3	Able to design Smart Cities and draft relevant project management schemes.
CO4	Application of smart solution.
CO5	Explain phases of Implementation and monitoring, 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, green field development, integrated planning approach.

- **SMART SOLUTIONS** **(08 Hours)**
  ICT in Smart City, Smart monitoring, Technology, Challenges, solutions and work around, replication and up-scaling, 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: 42 hours)

3. Books Recommended

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

4. Mapping of COs and PSOs

	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	2	2	3	3	3	3

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

5. 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

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

CE 434 Public Transport System Design and Operation

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** **(06 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 Stop.

- **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 (04 Hours)**
  Performance Evaluation – Efficiency, Capacity, Productivity and Utilization – Performance Evaluation Techniques and Application – System Network Performance – Transit Terminal Planning and Design.

(Total Lectures: 42 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 PSOs

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

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

5. Mapping of COs and PSOs

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

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

CE 436 Transportation Safety and Environment

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Analyse the 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.

2. Syllabus

- **INTRODUCTION** **(08 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** **(06 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 (07 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: 42 hours)

3. Books Recommended

1. R Lamm, B Psarianos, and T Mailaender, Highway Design and Traffic Safety Engineering Handbook, McGraw Hill Publishing, New York, 1999.
2. J Glasson, R Therivel and A Chadwick, Introduction to Environmental Impact Assessment, Routledge, London, 2007.
3. L W Canter, Environmental Impact Assessment, McGraw Hill Inc. Singapore, 1996.
4. J G Rau, and D C Wooten, Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.
5. Relevant IRC and NHAI guidelines.

4. Mapping of COs and PSOs

	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

0-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	2	1	3
CO4	1	1	2
CO5	1	2	2

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

CE 438 Waterways Infrastructure Planning and Design

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	Assess the available resources, and analyse the present and future requirement to plan and design harbour facilities
CO2	Gain detailed insights concerning the traffic demand for harbour planning
CO3	Differentiate harbour works, berthing structures and transit sheds.
CO4	Design coastal protection facilities and learning navigation aids
CO5	Assess repair facilities, port facilities and cargo handling facilities required.

2. Syllabus

- **HARBOUR PLANNING** **(08 Hours)**

  Types of water transportation, water transportation in India, requirements of ports and harbours, classification of harbours, selection of site and planning of harbours, location of harbour, traffic estimation, master plan, ship characteristics, harbour design, turning basin, harbour entrances, type of docks, its location and number, Site investigations – hydrographic survey, topographic survey, soil investigations, current observations, tidal observations.

- **HARBOUR WORKS** **(08 Hours)**

  Design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, navigational aids, requirements of signals, fixed navigation structures, necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar.

- **DOCKS AND REPAIR FACILITIES** **(08 Hours)**

  Harbor docks, use of wet docks, design of wet docks, repair docks, lift docks, dry docks, keel and bilge blocking, construction of dry docks, gates for dry docks, pumping plant, floating docks, slipways, locks, size of lock, lock gates, types of gates.

- **PORT FACILITIES** **(08 Hours)**

  Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities.

- **DREDGING AND COASTAL PROTECTION** **(06 Hours)**

  Classification, types of dredgers, choice of dredger, uses of dredged materials, coastal erosion and protection, sea wall, revetment, bulkhead, coastal zone and beach profile.

- **INLAND NAVIGATION** **(04 Hours)**

  Inland waterways, Inland water transportation in India, classification of waterways, economics of inland waterways transportation, national waterways.

(Total Lectures: 42 hours)

3. Books Recommended

16. B Cunningham, The Dock and Harbour Engineer's Reference Book: Being a Compilation of Notes on Various Matters Connected with Maritime Engineering and Ports and Harbours, Franklin Classics Trade Press, New York, 2016.
17. C A Thoresen, Port Designer's Handbook: Recommendations and Guidelines, Thomas Telford, Tokyo, 2006.
18. G P Tsinker, Handbook of Port and Harbor Engineering: Geotechnical and Structural Aspects, Springer, New York, 2014.
19. H P Oza and G H Oza, Dock and Harbour Engineering, 8th Edition, Charotar Publishing House Pvt. Ltd., Anand, 2016.
20. S B Junnarkar and HJ Shah, Dock and Harbour Engineering, Charotar Publishing House Pvt. Limited, Anand, 2010.

5. Mapping of COs and POs

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

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

6. 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	1	1	1

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

CE 442 Traffic Flow Theory

L	T	P	C
3	0	0	3

---

1. <u>Course Outcomes (COs)</u>

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

CO1	Investigate traffic flow characteristics and its variation at microscopic and macroscopic levels over space and time.
CO2	Distinguish various traffic flow theories for identifying key factors affecting traffic performance.
CO3	Apply the traffic flow theories for varying roadway and traffic conditions using various design and control parameters.
CO4	Examine vehicle-following behaviour under heterogeneous traffic conditions.
CO5	Apply programming and simulation skills to interpret and analyse data pertaining to Traffic Engineering problems.

2. <u>Syllabus</u>

- **TRAFFIC STREAM CHARACTERISTICS (08 Hours)**
  Measurement of microscopic and macroscopic traffic flow characteristics; Time-space plots; Study of Traffic Stream Characteristics - Flow, Speed and Concentration; Density measurement techniques, Use of Counting, Interval and Translated Distributions for Describing Vehicle Arrivals, Headways, Speeds, Gaps and Lags; Fitting of Distributions, Goodness of Fit Tests, gap acceptance behavior.

- **TRAFFIC STREAM MODELS (12 Hours)**
  Fundamental Equation of Traffic Flow, Speed-Flow-Concentration Relationships, 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.

- **SHOCKWAVE ANALYSIS (6 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** **(6 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 Lectures: 42 hours)

3. Books Recommended

1. B S Kerner, Introduction to Modern Traffic Flow Theory and Control, Springer, Berlin, Heidelberg, 2009.
2. D R Drew, Traffic Flow Theory and Control, McGraw Hill, New York, 1976.
3. A D May, Traffic Flow Fundamentals, 1st Edition, Prentice Hall, New Jersey, 1990.
4. R P E Roess, S Prassas and W R McShane, Traffic Engineering, 4th edition, Prentice Hall, New Jersey, 2010.
5. J Banks, J S Carson, B L Nelson, Discrete-Event System Simulation. 5th Edition. Prentice Hall, New Jersey, 2010.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 444 Advanced Hydraulic Structures

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 aspects of reservoirs.
CO2	Identify the methods of hydraulic structure design.
CO3	Design hydraulic structures.
CO4	Analyse weir and barrages, canal regulating structures.
CO5	Design and selection of cross drainage works and energy dissipaters.

2. Syllabus

- **PLANNING OF WATER RESOURCES ENGINEERING PROJECT (04 Hours)**
  Planning and investigations of reservoir and dam sites, Choice of dams, preparation and protection of foundation and abutments.

- **GRAVITY DAM (08 Hours)**
  Forces acting on solid gravity dam, modes of failures, stability analysis, elementary and practical profile of gravity dam, internal stresses and stress concentrations in gravity dam, joints, seals, keys in gravity dams, dam safety and hazard mitigation

- **EMBANKMENT DAM (08 Hours)**
  Classification of embankment dam, Homogeneous and zoned embankment dams, factors influencing design of embankment dams, criteria for safe design of embankment dam,

steps in design of embankment dam, seepage analysis and its control through dam and its foundation, design considerations for rock fill dam, instrumentation

- **SPILLWAYS AND ENERGY DISSIPATERS (08 Hours)**
  Capacity of spillways, components and profile of different types spillways, non-conventional type of spillways, selection and design of energy dissipaters, spillway aerator.

- **DIVERSION HEADWORK (07 Hours)**
  Components of diversion head works and their functions, design of weirs and barrages on permeable foundations

- **DESIGN OF CANAL AND CANAL STRUCTURE (07 Hours)**
  Canal regulation structures and design of cross drainage works, canal falls, operation and maintenance of canals. Review of codes of practice

(Total Lectures: 42 hours)

3. Books Recommended

1. USBR, Design of gravity dams, A Water Resources Technical Publication, Denver, Colorado, 1976.
2. G L Asawa, Irrigation and water resources engineering, New Age International Publishers, New Delhi, 2014.
3. W P Creager, J D Justin and J Hinds., Engineering for dams, Nemchand and Brothers, Roorkee, 1995.
4. R M Khatsuria, Hydraulics of spillways and energy dissipaters, CRC Press, Boca Raton, 2005.
5. P Novak, A Moffat, C Nalluri, and R Narayana, Hydraulic Structures, Taylor and Francis Group publishers, London, 2007.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

CO4	3	2	1
CO5	3	2	1

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

CE 446 Hydraulics of Alluvial Rivers

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	Estimate incipient motion condition of sediments.
CO2	Estimate flow resistance in alluvial rivers.
CO3	Compute transport of sediments in alluvial rivers.
CO4	Design lined and unlined stable channels.
CO5	Analyse planform and estimate bed level variations in alluvial rivers.

2. **Syllabus**

- **PROPERTIES AND INCIPIENT MOTION OF SEDIMENTS (10 Hours)**
  Nature of sediment problems, Origin and formation of sediments, individual and bulk properties of sediments, competent velocity, lift force and critical tractive stress concept on cohesion less and cohesive soils; regimes of flow; Resistance to flow in alluvial streams, resistance relations based on total resistance and division of resistance into grain and form resistance, preparation of stage discharge curves for alluvial streams, velocity distribution in alluvial channel, sediment Petrography (Sediment sampling)

- **BED LOAD TRANSPORTATION** **(11 Hours)**
  Bed load computation by empirical equations, dimensional considerations and semi theoretical equations for uniform and non-uniform sediments, saltation.

- **SUSPENDED LOAD TRANSPORTATION** **(08 Hours)**
  Mechanism of suspension, general equations of diffusion. Integration of sediment distribution equation, Differences between actual and theoretical exponents, prediction of reference concentration, Method of integrating curves of concentration and velocity. Simple relations for suspended load, Effect of temperature on suspended load, Wash load, Non-equilibrium transport of suspended load

- **STABLE CHANNEL DESIGN** **(05 Hours)**
  Design of lined and unlined channels for carrying clear and sediment laden water.

- **PLANFORM AND BED LEVEL VARIATIONS OF ALLUVIAL RIVERS** **(08Hours)**
  Hydraulic geometry of alluvial streams, bed level variation of alluvial streams, aggradations and degradation models, reservoir sedimentation, local scours.

(Total Lectures: 42 hours)

3. Books Recommended

1. S Dey, Fluvial hydrodynamics: Hydrodynamic and sediment transport phenomena, Springer- Verlag Berlin Heidelberg, 2014.
2. R J Garde and K G Ranga Raju, Mechanics of sediment transportation and alluvial stream problems, Third edition, New Age International (P) Limited, New Delhi, 2006.
3. R J Garde, River morphology, New Age International Publisher, New Delhi, 2006.
4. A J Raudkivi, , Loose boundary hydraulics, Pergamon Press, Oxford, 1976.
5. M S Yalin, , Mechanics of sediment transport, Pergamon Press, Oxford,1976

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

CO5	3	2	3

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

CE 448 Computational Hydraulics

L	T	P	C
3	0	0	3

---

1. Course Outcomes (COs)

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

CO1	Classify type of equation used for describing physical progress of fluid motion.
CO2	Solve the simultaneous linear and non-linear equations
CO3	Apply the concepts of fluid motion on real world problems related to water flow.
CO4	Apply the Finite Difference Method for solution of fluid motion equations.
CO5	Solve the real world problems related to water flow

2. Syllabus

- **BASIC CONCEPTS OF FLUID MOTION** **(14 Hours)**
  Basic Concepts – Lagrangian and Eulerian methods of describing fluid motion, acceleration and deformation of fluid elements, Laws governing fluid motion, continuity,

Euler's equation, Energy equation, Saint Venant equation, classification of partial differential equations.

- **NUMERICAL TECHNIQUES FOR SOLUTION OF PARTIAL DIFFERENTIAL EQUATION (14 Hours)**
  Review of linear algebra, solution of simultaneous linear algebraic equations-matrix inversion, solvers-direct methods, elimination methods, ill conditioned systems, Gauss-Seidel method, successive over relaxation method, Finite difference method.

- **ENGINEERING APPLICATIONS (14 Hours)**
  Application to water resources problems in open channel flows, Pressure Flow, ground water flows, and unsaturated flows through porous media.

(Total Lectures: 42 hours)

3. Books Recommended

1. C F Gerald and P O Wheatley, Applied Numerical Analysis, Addison Wesley Publishing Company, New York, 1994.
2. H M Choudhary, Open Channel Flows, Prentice Hall of India, New Delhi, 1994.
3. M B Abbott, Computational Hydraulics, Pitman Publishing House, London, 1979.
4. J A Cunge, F M Holly, and A Verway, Practical Aspects of Computational River Hydraulics, Pitman Publishing House, London, 1980.
5. G Pinder and W G Gray, Finite Element Simulation in Surface and Subsurface Hydrology, Academic Press, New York, 1997.

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	2	1	2	1	2	1	2	1	1	1	1	3
CO3	2	3	3	1	3	1	1	1	1	1	2	2
CO4	2	3	3	1	3	1	1	1	1	1	2	2
CO5	3	2	2	1	2	1	2	1	1	1	1	3

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

5. Mapping of COs and PSOs

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

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

CE 452 Geospatial Techniques

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 fundamentals of Remote Sensing
CO2	Apply digital image processing
CO3	Explain fundamentals and processes of GIS
CO4	Apply GPS technology and different methods of measurements
CO5	Solve complex civil engineering applications using Geospatial Techniques

2. **Syllabus**

- **INTRODUCTION** **(01 Hours)**
  Introduction to geospatial techniques - Benefits and applications of geospatial techniques

- **REMOTE SENSING** **(08 Hours)**
  Fundamentals of remote sensing - Energy interactions - Ideal remote sensing systems, - Fundamentals of interpretation - Basic equipment used for interpretation - Elements of air photo interpretation - Interpretation keys - Different types of sensors - Platforms and remote sensing images.

- **DIGITAL IMAGE PROCESSING** **(05 Hours)**
  Characteristics of a digital image –Digital Image processing techniques– Image registration – Digital image interpretation techniques.

- **GEOGRAPHICAL INFORMATION SYSTEMS** **(10 Hours)**
  Introduction - Geo referenced data - Data input and output - Data quality and management - GIS analysis functions - Implementation of GIS - Principles and methods of data collection – Digital Elevation Models.

- **GLOBAL POSITIONING SYSTEM** **(10 Hours)**
  Earth Surface, datum – Co-ordinate systems - Segments of GPS System - GPS receivers and its components - Different methods of observation.

- **ENGINEERING APPLICATIONS** **(08 Hours)**
  Application of Remote Sensing, GIS and GPS in different areas of Civil Engineering, Software in Geospatial Techniques
  .

(Total Lectures: 42 hours)

3. Books Recommended

1. M Lillesand and RW Kiefer, Remote Sensing and Image Interpretation, John Willey, New York, 2015.
2. A M Chandra and S K Ghosh, Remote Sensing and Geographical Information System, Narosa Publishing, New Delhi, 2006.
3. G S Srivastava, An Introduction to Geoinformatics, Mc Graw Hill, New Delhi, 2014.
4. N K Agrawal, Essentials of GPS, Spatial Network, Hyderabad, 2004.
5. C P Lo and A K W Yeung, Concept and Techniques of Geographical Information Systems, PHI Learning, New Delhi, 2008.

4. Mapping of COs and POs

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

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

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

5. Mapping of COs and PSOs

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

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

CE 454 Advanced Water and Wastewater Treatment

L	T	P	C
3	0	0	3

---

1. Course Outcomes (COs)

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

CO1	Analysis the quality and quantity of water and wastewater.
CO2	Describe primary and secondary water and wastewater treatment processes.

CO3	Explain basic theory for designing different units of water and wastewater treatment plants.
CO4	Describe advance water treatment process, including natural processes.
CO5	Apply reclamation, recycling and reuse of wastewater.

2. Syllabus

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

- **WATER AND WASTEWATER TREATMENT PROCESSES** **(10 Hours)**
  Types of sedimentation-Plat settlers, Diffusion double layer theory for colloids, Mechanisms of destabilization of colloids, Jar tests , Perikinetic and Orthokinetic Flocculation, Velocity Gradient, Clari-flocculator, Mechanisms of filtration, mono media and multimedia filters kinetics of disinfection, types of aerators , Film coefficients and equilibrium relationship for aeration.

- **ADVANCE WATER AND WASTEWATER TREATMENT PROCESSES** **(10 hours)**
  Equalization – Neutralization - Secondary treatment units and their design concepts- Trickling filter, Activated sludge process, stabilization ponds, lagoons – oxidation ditch. Wastewater disinfection. Aquatic Plant Systems, Constructed Wetlands and Vermi-culture.

- **RECLAMATION AND REUSE OF WASTEWATER** **(12 hours)**
  Tertiary treatment for removal of residual organics, removal of nutrients, recycling and reuse of wastewater. Membrane Filtration Technology. Advanced Oxidation Technology. Working principle, application and maintenance of Ion-exchange, reverse osmosis, adsorption, ultra- filtration, electro-dialysis. Desalination. Adsorption – Isotherms – Advance Oxidation Process

.

(Total Lectures: 42 hours)

3. Books Recommended

1. R L Droste and R L Gehr, Theory and Practice of Water and Wastewater Treatment, Wiley Publication, New Delhi, 2018.
2. Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, Tata McGraw-Hill, New Delhi, 2003.
3. D G Rao, R Senthilkumar, J A Byrne, and S Feroz, Wastewater Treatment Advanced Processes and Technologies, CRC Press, New York, 2012.
4. M L Davis, Water and Wastewater Engineering, McGraw-Hill, New Delhi, 2010.

5. Manual on Water Supply & Treatment 3rd Ed. Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, Govt. of India, New Delhi, 1999.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 456 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** **(04 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** **(08 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: 42 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 458 Metro Construction Technology

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Analyze needs of metro construction project.
CO2	Prepare construction schedules and manage metro construction projects
CO3	Illustrate underground construction and tunnel boring technology
CO4	Design precast concrete and understand fundamentals of metro rail
CO5	Demonstrate railway technology for metro projects

2. Syllabus

- **METRO PROJECT FUNDAMENTALS** **(4 Hours)**
  Concept of rapid transit systems, requirements of rapid transit systems. types of rapid transit systems, concept of metro rail transit system, terminology of metro construction, advantages and disadvantages of metro, metro construction projects in India

- **UNDERGROUND CONSTRUCTION** **(12 Hours)**
  Need for underground construction, fundamentals of underground constructions, planning for underground construction, site preparations, characteristics of soil and basics of geotechnical engineering, methods of underground construction, top-down constriction method, bottom-up construction method, safety during underground construction, workers health and safety provisions, regulations of underground construction

- **TUNNEL CONSTRUCTION** **(12 Hours)**
  Fundamentals theories of tunnel construction, types of tunnels, different cross-sections of underground tunnels, methods of tunnel boring, tunnel boring machine (TBM), parts of TBM, working procedure of TBM, procedure of tunnel construction using TBM, stations construction during tunnels, removal and dumping of excavated materials

- **PRECAST CONCTERE TECHNOLOGY** **(8 Hours)**
  Fundamentals of pre-cast concrete technology, Requirements of precast concrete elements in metro construction, Theories of formwork for precast concrete, curing of precast concrete, Admixtures and ingredients of precast concrete, Transportation off precast segments, Precast segments of tunnel, Precast bridge segments, Fundamentals of precast concrete bridge construction

- **METRO RAIL** **(6 Hours)**
  Fundamentals of railway construction, terminology of railway and its components, Railway systems, Railway track construction, Components of railway track, Rail signaling, Introduction to electric supply for metro rail.

(Total Lectures: 42 hours)

3. Books Recommended

1. M Ramachandran, Metro Rail Projects in India: a Study in Project Planning, Oxford University Press, New Delhi, 2011.
2. R K Goel, B Singh and J Zhao, Underground Infrastructures: Planning, Design and Construction, Butterworth-Heinemann, Oxford, 2012.
3. S Chandra, Railway Engineering, Oxford University Press, New Delhi, 2008.
4. K S Elliott, Precast Concrete Structures, CRC Press, Boca Raton, 2016.
5. 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	2	3	3	3	1	2	3	1	1	1	2	3
CO2	3	1	2	2	3	1	1	2	3	1	3	2
CO3	3	1	2	2	3	1	2	1	2	2	1	2
CO4	3	1	3	1	3	1	2	1	2	1	1	1
CO5	1	2	1	1	3	2	3	2	2	3	2	3

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

5. Mapping of COs and PSOs

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

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

L	T	P	C

CE 462 Environmental Impact Assessment

3	0	0	3

1. Course Outcomes (COs)

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

CO1	Introduce EIA and EIA methodologies.
CO2	Analyze prediction and evaluation of environmental impacts of new projects.
CO3	Describe socio-economic assessment and public participation.
CO4	Apply legal provisions and statutory requirement for environmental protection.
CO5	Evaluate public participation and public hearing in EIA.

2. Syllabus

- **IMPACT ASSESSMENT – TYPES AND SIGNIFICANCE (06 Hours)**
  Types of impacts – Significant impacts – Various impact assessments viz. Health impact assessment, Social Impact Assessment, Disaster Impact Assessment, Environment Impact Assessment Rules-1994, EIA Notification-2006.
- **EIA: INTRODUCTION (06 Hours)**
  Evolution of EIA – EIA at project, regional and policy levels – Environmental clearance procedures in India – EIA Rules 1994 and amendments.
- **EIA: PLANNING (09 Hours)**
  Screening - Baseline data collection – Terms of Reference – Scoping – Identification of impacts - Rapid and Comprehensive EIA – Monitoring, analysis and report preparation in EIA.
- **EIA: METHODOLOGIES AND STRATEGIES (15 Hours)**
  Prediction of impacts of physical, biological and socio–economic environment – Impact prediction tools / techniques such as Adhoc method, checklist method etc – Development of environment management plan – Post project monitoring – EIA report and EIS – Review process – EIA case studies / histories.
- **PUBLIC PARTICIPATION (06 Hours)**
  Project Affected Persons - Significance of public participation in EIA – Methods of public consultation – Public Notice and Public Hearing - Resettlement and rehabilitation issues.

(Total Lectures: 42 hours)

3. Books Recommended

1. LW Canter, Environmental Impact Assessment, Tata McGraw Hill Co, Singapore, 1996.
2. R E Munn, Environmental Impact Assessment, John Wiley and Sons, Toronto, 1979.

3. S KDhameja, Environmental Engineering and Management, S. K. Kataria and Sons, Delhi. 2004.
4. Relevant MoEF Notifications and CPCB / GPCB Acts and Rules, New Delhi.
5. R Hillary, Environmental Management Systems and Cleaner Production, Wiley Publishers, New York, 1997.

4. Mapping of COs and POs

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

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

CE 464 Construction Laws

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	Assess legal and commercial framework of construction contracts
CO2	Analyze claims for losses as per the Indian laws
CO3	Demonstrate roles of the various Indian Acts in construction
CO4	Analyze international contracts
CO5	Apply different techniques of dispute resolution in projects

2. Syllabus

- **LEGAL AND COMMERCIAL FRAMEWORK (3 Hours)**
  Introduction, the power of governments, agency regulation, statute law, application of law, contractor, subcontractor, consultant, supplier, government, funder, etc.
- **CONSTRUCTION CONTRACTS AND MANAGEMENT (6 Hours)**
  Contract specification, types of contract documents used for construction, selection of a contractor, standard of work, use of construction management contracts, allocation of risk in construction management, contents of construction management contracts
- **CONTRACTORS CLAIMS FOR LOSS AND EXPENSES (6 Hours)**
  Contract claims and damages, grounds for claims, claims procedures, quantification of procedure, insurance, bonds and guarantees
- **THE INDIAN CONTRACT ACT, 1871 (6 Hours)**
  Definition of a contract and its essentials, formation of a valid contract - offer and acceptance, consideration, capacity to contract, free consent, legality of object, discharge of a contract by performance, impossibility and frustration, breach, damages for breach of a contract, quasi contracts, special contracts contract of indemnity and guarantee, contract of bailment and pledge, contract of agency
- **THE COMPANIES ACT, 1956 (6 Hours)**
  Nature and definition of a company, registration and incorporation, memorandum of association, articles of association, employee welfare, strategic human resource development; employment legislation, labour legislations: industrial dispute act, factories

act, payment of wages act, workmen's compensation act. Important provisions of employees' state insurance act, payment of gratuity act, employees provident fund act

- **THE BUILDING AND OTHER CONSTRUCTION ACT, 1996 (3 Hours)**
  Registration of establishment, registration of building workers, building and other construction workers welfare boards, conditions of service of building workers, safety and health measures, special provisions, penalties and provisions.
- **REAL ESTATE (REGULATION AND DEVELOPMENT ACT, 2016) (4 Hours)**
  Objectives and techniques of site investigation, decision process for choosing foundation, general failures, classifications introduction, registration of real estate project, functions and duties of promoter, rights and duties of allotted, the real estate appellate tribunals, role of company secretaries, offences and penalties, agreement for sale between promoter and allottee
- **DISPUTE RESOLUTION (4 Hours)**
  Background of dispute, the nature of construction dispute, the role of contractor, method of dispute resolution, arbitration, litigation, adjudication, alternative dispute resolution procedure
- **INTERNATIONAL CONTRACTS (4 Hours)**
  Introduction to FIDIC, the necessity of FIDIC contract, contract administration and claims, risk, insurance and securities, remedies and dispute resolution

(Total Lectures: 42 hours)

3. Books Recommended

1. J Coggins, T Davie, T Ears and P Evans, Understanding Construction Law, LexisNexis Butterworths, Chatswood, 2016.
2. E Baker, B Mellors, S Chalmers and A Lavers, FIDIC Contracts Law and Practices, Routledge, Taylor & Francis Group, London, 2009.
3. J Bailey, Construction Law, Taylor and Francis Group, Oxford, 2011.
4. G Kelley, Construction Law: An Introduction for Engineers, Architects, and Contractors, John Wiley & Sons, New Jersey, 2012.
5. V Bhatt and P Vyas, Laws for Engineers (Contract, Arbitration, Evidence, Limitations), Second Edition, ProCare, New Delhi, 2015.

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 466 Professional Practice

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	Prepare tender and contract documents following Acts and byelaws.
CO2	Prepare valuation report for Civil engineering projects.
CO3	Solve the disputes in construction industries through Arbitration.
CO4	Apply for registration of IP rights like patent, design, trademark, etc.
CO5	Act as team member / leader in all type of organizations with its legal responsibilities as per prevailing Acts.

2. Syllabus

- **OFFICE PRACTICE** **(04 Hours)**
  Organisational set up, working of professional firms, office procedures, construction contracts, legal aspects, professional charges, the role of architect, developer, builder and contractor.

- **TENDERING AND CONTRACTING** **(10 Hours)**
  Tender and tendering process, types of tenders, Dynamics of contracting, contract documents, condition of contract, Indian contract act, improper work and defect liability period, liquidated damages, contract breach, certificates and payments, duties and liabilities.

- **ARBITRATION AND EASEMENT** **(08 Hour)**
  The purpose of arbitration, the powers and duties of arbitrator, arbitration and building contract. Types of arbitration, fire insurance, easement characteristics types.

- **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.

- **P.W.D. ACCOUNTS AND PROCEDURE OF WORKS** **(04 Hours)**

Organisation set up, classification of work, execution of work, bookkeeping, measurement book, store procedure, mode of payments, public works accounting system.

- **ENTREPRENEURSHIP DEVELOPMENT (02 Hours)**
  Concept need and scope of entrepreneurship, characteristic of entrepreneurship, forms of business organization.

- **IPR AND PATENT ACT (02 Hours)**
  Importance and scope, forms of IPR, patents, copy rights, trademarks, relevant acts.

(Total Lectures: 42 hours)

3. Books Recommended

1. B S Patil, Civil Engineering Contracts and Estimates, 4th Edition, Orient BlackSwan Pvt. Ltd., Hyderabad, 2015.
2. B N Dutta, Estimating and Costing in Civil Engineering (Theory and Practice), 28th Revised Edition, UBS Publishers' Distributors Pvt. Ltd., New Delhi, 2016.
3. R H Namavati, Professional Practice, 1st Edition, Lakhani Book Depot, Mumbai, 2016.
4. S K Guha Thakurta and K R Shah, Manual of Construction Project Management, 1st Edition, Multi-tech Publishing Co., Mumbai, 2003.
5. P C Tulsian, Business Organization and Management,1st Edition, Pearson Education, New Delhi, 2002.

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	2	2	2	2	2	1
CO2	2	1	1	1	1	1	1	1	1	1	1	1
CO3	2	2	2	1	1	1	1	1	1	1	1	1
CO4	1	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	2	2	1	1

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

5. Mapping of COs and PSOs

	PSO1	PSO2	PSO3
CO1	1	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 468 Advanced Construction Technology

L	T	P	C
3	0	0	3

1. Course Outcomes (COs)

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

CO1	Apply special and modern construction technologies
CO2	Illustrate modern construction and building materials
CO3	Execute prefab, underground and offshore construction
CO4	Employ automation techniques in construction
CO5	Apply virtual technologies in construction

2. Syllabus

- **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, modern piling technology, pile driving machineries, sheet piling, well and caisson, diaphragm walls, dewatering techniques and design of dewatering system, surface finishing materials techniques and advanced curing technologies

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

- **MODERN BUILDING MATERIALS** **(08 Hours)**
  Artificial manufactured sand and its application areas, different fly ash and its applications, different slag like steel slag and blast furnace slag and its applications,

geosynthetics like geogrid, geofoam, geomembrane, geojute and geotextiles. geopolymers and its applications, fibers in concrete like steel fiber, polypropylene fibers and glass fibers

- **PREFAB CONSTRUCTION TECHNOLOGIES (08 Hours)**
  Reinforced concrete based technologies- precast concrete technology, monolithic concrete structure with aluminum formwork. structural steel based technologies- pre-engineered building (PEB) technology, light gauge steel frame structure (LGSF) technology. expanded polystyrene (EPS) technology, other technologies – glass fiber reinforced gypsum (GFRG) technology, wood house technology, polypropylene honeycomb panels technology, polyurethane foam (PUF) panel technology

- **UNDERGROUND AND OFFSHORE CONSTRUCTION (06 Hours)**
  Site investigation and geological studies, top down and bottom up underground construction, pneumatic breakers, advanced drilling methods, blasting and explosives. Different tunneling technologies like mechanized, shield, micro etc. offshore: barges, cranes, derrick barges drilling vessels, different stages of offshore construction, offshore facilities and fabrication methods, safety in underground and offshore construction

- **AUTOMATION IN CONSTRUCTION (6 Hours)**
  Advance computer technology in construction, internet of things (IoT) in construction, RFID technology, building information modelling, virtual design and construction technologies, augmented and virtual reality (AR & VR) in construction, artificial intelligence (AI) in construction.

(Total Lectures: 42 hours)

3. Books Recommended

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

4. Mapping of COs and POs

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

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

5. Mapping of COs and PSOs

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

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

CE 472 Operation and Maintenance Management of Pavements

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	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.

2. Syllabus

- **INTRODUCTION** **(06 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** **(06 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 (06 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: 42 hours)

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.

4. 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

0-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	2	3
CO4	3	3	3
CO5	3	3	3

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

CE 407 Project

L	T	P	C
0	0	10	5

---

1. Course Outcomes (COs)

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

CO1	Demonstrate sound technical knowledge of selected problem as a project work pertaining to civil engineering domain.
CO2	Assimilate the art of literature review and appropriate usage of modern tools and techniques relevant to selected problem.
CO3	Develop the methodological framework and carryout design of experiments related to Field/Laboratory/Computational investigations leading to valid conclusion.
CO4	Acquire the skill of writing and presenting comprehensive technical report/document.
CO5	Exhibit tendency of lifelong learning, professional ethics and function as a member or leader in a team.

2. Discription

It will be taken up by the student at the end of the seventh semester and the duration would be of six months. This is aimed at training the students to analyse independently any problem paused to them. The work may be analytical, experimental, numerical, design or combination of these. 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.

3. 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

4. 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

CE 402 Industrial Internship

L	T	P	C
0	0	40	10

---

1. Course Outcomes (COs)

At the end of the industrial internship the students will be able to:

CO1	Provide potential opportunities to learn understand and sharpen the real-time technical/managerial skills required at the job.
CO2	Comprehend the psychology of the team members, their habits, attitudes, and approach to problem-solving
CO3	Apply the technical knowledge gained during the course to solve real field problems.
CO4	Compile the information in connection with the task accomplished during the industrial training in the form of a report.

2. Objectives of the Industrial Training:

i. Exposure to technical students to the industrial culture, which cannot be simulated in the classroom.
ii. Exposure to the current technological developments relevant to the subject area provides opportunities to learn, comprehend and improve real-time technical/managerial skills.
iii. Acquaintance with various materials, processes, products, and their applications, along with

the relevant aspects of quality control.

iv. Understand the social, economic, and administrative considerations that influence the working environment of industrial organizations. In addition, the psychology of the workers and their habits, attitudes, and approach to problem solving.

v. Learn to apply the technical knowledge in real industrial situations and use the experience in writing technical reports/projects.]

3. Objectives of the Industrial Training:

i. Accessible to well-trained candidates for employment and Students take new perceptions to solve a real-world problem.
ii. Quality candidate's availability for temporary or seasonal positions and projects
iii. Freedom for industrial staff to pursue more projects that are creative.
iv. Established a cost-effective way to the employee and assess the employees' potential.

4. Objectives of the Industrial Training:

i. Provides a good platform to build good relations and linkages with the industry
ii. Makes the placement process easier.
iii. Curriculum revision can be made based on the feedback from industry/students.
iv. Provides a base for improvement in the teaching-learning iterative process.

5. Benefits to the Students:

i. Provides an opportunity to be hired by the industry/organization.
ii. Creates prospects to see how the theoretical aspects learned during the course work are extended/integrated/applied in the real field conditions. On-floor experience provides a much better professional experience.
iii. Help the students to decide the avenue towards a profession that could be the best career option for them to pursue.
iv. Opportunity to learn new skill-sets, multi-tasking, supplement knowledge, strategies like time management, etc.
v. Opportunity to improve upon communication skills and teamwork.

6. Mapping of COs and POs

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

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

7. Mapping of COs and PSOs

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

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