Course Curriculum
(Course Structure and Syllabi)
for
Bachelor of Technology
in
Civil Engineering

(Second Year Onwards)

Department of Civil Engineering

National Institute of Technology

Hamirpur

Hamirpur – 177005 (India)

Department of Civil Engineering

Second Year												
3rd Semester							4th Semester					
SN	**Code**	**Subject**	**L**	**T**	**P**	**Credits**	**Code**	**Subject**	**L**	**T**	**P**	**Credits**
1	MA-211	Engineering Mathematics	3	0	0	3	CE-221	Indeterminate Structures	3	1	0	4
2	CE-211	Determinate Structures	3	1	0	4	CE-222	Water Resource Engineering-I	3	0	0	3
3	CE-212	Fluid Mechanics	3	1	0	4	CE-223	Soil Mechanics	3	0	0	3
4	CE-213	Engineering Geology and Rock Mechanics	3	0	0	3	CE-224	Building Materials and Construction	3	0	0	3
5	CE-214	Surveying	3	0	0	3	CE-225	Building Materials Lab	0	0	2	1
6	CE-215	Fluid Mechanics Lab	0	0	2	1	CE-226	Structural Analysis Lab	0	0	2	1
7	CE-216	Surveying Practice	0	0	2	1	CE-227	Soil Mechanics Lab	0	0	2	1
8	CE-217	Computer-Aided Drafting Lab	0	0	2	1	CE-241-244	Discipline Elective-I	3	0	0	3
							SA-201-209	LA/CA	1	0	0	1
		Total	**Hours = 23**			**20**		**Total**	**Hours = 23**			**20**

Department of Civil Engineering

Discipline Elective-I

CE-241	Concrete Technology
CE-242	Remote Sensing
CE-243	Disaster Management
CE-244	Ground Water Engineering

Department of Civil Engineering

Third Year												
5th Semester							6th Semester					
SN	**Code**	**Subject**	**L**	**T**	**P**	**Credits**	**Code**	**Subject**	**L**	**T**	**P**	**Credits**
1	CE-311	RCC Design	3	1	0	4	CE-321	Foundation Engineering	3	1	0	4
2	CE-312	Water Supply and Treatment	3	0	0	3	CE-322	Wastewater Treatment and Management	3	0	0	3
3	CE-313	Highway Engineering	3	0	0	3	CE-323	Water Resource Engineering-II	3	0	0	3
4	CE-314	Highway Engineering Lab	0	0	2	1	CE-324	Structural Drawing	0	0	2	1
5	CE-315	Environmental Engineering Lab-I	0	0	2	1	CE-325	Environmental Engineering Lab-II	0	0	2	1
6	CE-301-304	Open Elective	3	0	0	3	CE-341-344	Discipline Elective-III	3	0	0	3
7	CE-351-353	Discipline Elective-II	3	0	0	3	CE-361-364	Discipline Elective-IV	3	0	0	3
8	HS-311	HSS	2	0	0	2	CE-381-384	Stream Core-I	2	0	0	2
		Total	**Hours = 22**			**20**		**Total**	**Hours = 22**			**20**

Department of Civil Engineering

Open Elective

CE-301	Building Materials and Construction
CE-302	Disaster Management
CE-303	Air Pollution Control
CE-304	CPM and PERT

Discipline Elective-II

CE-351	Computational Fluid Dynamics
CE-352	Geographic Information System
CE-353	Air Pollution Control

Discipline Elective-III

CE-341	Advanced RCC Structural Design
CE-342	Reinforced Earth
CE-343	Solid Waste Management
CE-344	Watershed Development and Management

Discipline Elective-IV

CE-361	Environmental Geo-technology
CE-362	Earthquake Resistant Design of Structures
CE-363	Railways, Airports, and Waterways
CE-364	River Mechanics and Sediment Transport

Stream Core-I

CE-381	Probability and Statistics in Transportation Engineering
CE-382	Water Resources System Modelling
CE-383	Matrix Method of Structural Analysis
CE-384	Management of Industrial Waste

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Fourth Year												
7th Semester							8th Semester					
SN	**Code**	**Subject**	**L**	**T**	**P**	**Credits**	**Code**	**Subject**	**L**	**T**	**P**	**Credits**
1	CE-411	Steel Structures	3	0	0	3	CE-461-464	Stream Elective-I	3	0	0	3
2	CE-412	Traffic Engineering and Transportation Planning	3	0	0	3	CE-481-484	Stream Elective-II	3	0	0	3
3	CE-413	Quantity Surveying and Estimating	3	0	0	3	CE-498	General Proficiency (Holistic Assessment)	0	0	0	2
4	CE-414	Hydraulics Lab	0	0	2	1	CE-499	UG Project/Internship	0	0	12	12
5	CE-415	Computational Lab	0	0	2	1						
6	CE-416	Vocational/Industrial Training	2	0	0	2						
7	CE-431-434	Discipline Elective-V	3	0	0	3						
8	CE-451-454	Stream Core-II	2	0	0	2						
9	CE-471-474	Stream Core-III	2	0	0	2						
		Total	**Hours = 22**			**20**		**Total**	**Hours = 18**			**20**

Discipline Elective-V

CE-431	Advanced Steel Structural Design
CE-432	Design of Hydraulic Structures
CE-433	Forensic Geotechnical Engineering
CE-434	Optimization Methods

Stream Core-II

CE-451	Elementary Structural Dynamics
CE-452	Probabilistic Methods and Stochastic Hydrology
CE-453	Ground Improvement Techniques
CE-454	Construction Management

Stream Core-III

CE-471	Pre-stressed Concrete
CE-472	Geo-synthetics
CE-473	Open Channel Hydraulics
CE-474	Road Safety Engineering

Stream Elective-I

CE-461	Hydro Power Engineering
CE-462	Bridge Engineering
CE-463	Structural Health Monitoring & Retrofitting of Structures
CE-464	Environmental Impact Assessment

Stream Elective-II

CE-481	Elementary Finite Element Method
CE-482	Water Resources Planning & Management
CE-483	Computation Techniques in Civil Engineering
CE-484	Geotechnical Earthquake Engineering

Department of Civil Engineering

Minor Degree												
5th Semester							6th Semester					
SN	Code	Subject	L	T	P	Credits	Code	Subject	L	T	P	Credits
1	CE-310	Fundamentals of Surveying	3	0	0	3	CE-320	Civil Engineering Materials and Construction	3	0	0	3
		Total	**Hours = 3**			**3**		**Total**	**Hours = 3**			**3**

Minor Degree												
7th Semester							8th Semester					
SN	Code	Subject	L	T	P	Credits	Code	Subject	L	T	P	Credits
1	CE-410	Environmental Engineering	3	0	0	3	CE-420	Construction Project Management	3	0	0	3
		Total	**Hours = 3**			**3**		**Total**	**Hours = 3**			**3**

Semester Wise Credits (Minor Degree)					
Semester	**5th**	**6th**	**7th**	**8th**	**Total**
Credits	3	3	3	3	**12**
Hours/week	3	3	3	3	**12**

Course Name: **Determinate Structures**
Course Code: **CE-211**
Course Type: **Discipline Core**

Contact Hours/Week: **3L+1T** Course Credits: **04**

Course Objectives:

- To understand the state of stress and strain in solids.
- To understand the force and displacement response of determinate beams, frames, trusses, cables and arches.
- Provide basic energy-based analysis techniques for analyzing structures.
- To understand the importance of analysis and arrive at design forces for above structures.

Unit Number	Course Content	Contact Hours
UNIT-01	**General state of Stress and Strain in solids:** Concept of stress, normal stress and shear stress, two-dimensional state of stress, transformation of stresses, principal stresses. Concept of strain, normal and shear strain, two-dimensional state of strain, Poisson's ratio, volumetric strain, principal strains, Mohr circle.	**07L**
UNIT-02	**Analysis of Statically Determinate Structures:** Pin jointed Frames Analysis Using Method of Joints, Method of Section, Graphical Method, and Tension coefficient Methods. Bending moment, shear force and axial force diagrams in determinate beams and frames.	**06L**
UNIT-03	**Slope and Deflection in beams:** Differential equation of elastic curve, Double integration method, Macaulay's method, Moment area Method, Conjugate beam Method and Strain energy method, deflection due to shear.	**08L**
UNIT-04	**Elastic theorems and energy principles**: Strain energy due to axial load ,bending, shear and torsion - principle of superposition - principle of virtual work - Castigliano's theorem - theorem of complementary energy -Betti's theorem - Maxwell's law of reciprocal deflections - application of method of virtual work (unit load method) and strain energy method for determination of deflections of statically determinate structures, temperature effects.	**07L**
UNIT-05	**Rolling/Moving loads and Influence lines diagrams for Determinate structures:** Introduction to moving loads - concept of influence lines - influence lines for reaction, shear force and bending moment in simply supported beams - influence lines for forces in trusses - analysis for different types of moving loads - single concentrated load - several concentrated loads - uniformly distributed load shorter and longer than the span, application of ILD.	**07L**
UNIT-06	**Introduction to Cables, suspension bridges and Arches**: Analysis of forces in cables - theory of arches -linear arch– Eddy's theorem - analysis of three-hinged arches.	**05L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Compute the state of stress and strain in solids.
CO2: Identify the concept of analysis of determinate structures.
CO3: Analyze and determine slope and deflection of determinate trusses, beams, and frames.
CO4: Apply principles and algorithms for analysis of determinate structures.
CO5: Assess the results obtained by solving above problems

Books and References:

1. Structural Analysis by R.C. Hibbeler, Pearson.
2. Fundamentals of Structural Analysis by K.M. Leet, C. Ming Uan, G &A.M. Gilbert, Tata McGraw Hill Education.
3. Structural Analysis by Devdas Menon, Narsoa.
4. Theory of Structures Vol-I&II by G.S. Pandit, S.P. Gupta & R. Gupta, Tata McGraw Hill Education.
5. Structural Analysis by L.S. Negi & R.S. Jangid, TATA McGraw Hill education.
6. Theory of Structures by S. Ramamrutham & R. Narayan, Dhanpat Rai & Son.
7. Basic Structural Analysis by C.S. Reddy TATA McGraw Hill education.
8. Theory of Structures by B.C. Punmia, Ashok Kumar Jain & Arun Kumar Jain, Laxmi.
9. Structural Analysis I & II by S.S. Bhavikatti, Vikas.
10. Gere, J.M., Mechanics of Materials, Thomson, Singapore, 2001.
11. Popov, E.P., Mechanics of Materials, Prentice Hall India, New Delhi, 2002.
12. Beer, F. P. and Johnston, E. R., Mechanics of Materials, Tata McGraw Hill, New Delhi, 2005

Course Name: **Fluid Mechanics**
Course Code: **CE-212**
Course Type: **Discipline Core**

Contact Hours/Week: **3L+1T** Course Credits: **04**

Course Objectives:

- To impart knowledge about the fluid properties and mechanics of fluid flow.
- To introduce the fundamental concepts relevant to fluid statics, kinematics, dynamics, fluid flow through pipes and open channels, and different types of flows.
- To enable the students to understand the factors characterizing fluid and flow behavior.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction:** Fluid properties, mass density, specific weight, specific volume and specific volume and specific gravity, surface tension, capillarity, pressure inside a droplet and bubble due to surface tension, compressibility viscosity, Newtonian and Non-Newtonian fluids, real and ideal fluids.	**04L**
UNIT-02	**Fluid Statics:** Fluid pressure and its measurement, hydrostatic forces on submerged bodies, buoyancy and floatation.	**05L**
UNIT-03	**Fluid Kinematics and Dynamics:** Continuity equation, rotational and irrotational flow, circulation and vorticity, velocity potential and stream function, flow net, Euler's equation, Bernoulli's equation, and its applications.	**08L**
UNIT-04	**Flow Through Pipes:** Darcy-Weisbach equation, energy losses in pipelines, equivalent pipes, multiple pipe systems, siphon, and three reservoir problem.	**04L**
UNIT-05	**Laminar and Turbulent flows:** Reynolds experiment, Laminar flow between parallel plates, Laminar flow in pipes, characteristics of turbulent flow, turbulent flow in smooth and rough pipe, Concepts of boundary layer, boundary layer thickness, momentum integral equation, boundary layer separation and its control.	**08L**
UNIT-06	**Dimensional analysis and similitude:** Dimensional homogeneity, Buckingham's π theorem, geometric, kinematic, and dynamic similarity, model studies.	**04L**
UNIT-07	**Drag and Lift:** Types of drag, Drag and Lift coefficient, Pressure drag and Friction drag characteristics on Sphere, Cylinder, and Disc, Circulation, Lift and Magnus effect, Lift Characteristics of air foils, Induced drag	**03L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify basic properties of fluid and analyse fluid flow behavior.

CO2: Describe the problems involving fluid properties, continuity and Bernoulli's equations, energy losses through pipes, turbulent flows, dimensional analysis, and flow through open channels.

CO3: Apply principles and fundamental relations to solve problems mentioned in CO2

CO4: Evaluate the results obtained by solving above problems.

Books and References:

1. Fluid Mechanics and Machinery by Ojha, Berndtsson and Chandramouli,
2. Fluid Mechanics by A.K. Jain,
3. Hydraulics and Fluid Mechanics by P.N.Modi and S.M.Seth,
4. Fluid Mechanics by Wiley and Streeter,
5. Fluid Mechanics by F.M. White,
6. Flow in open Channels by K. Subramanya
7. Open Channel Flow by K.G. Rangaraju.

Course Name: **Engineering Geology and Rock Mechanics**
Course Code: **CE-213**
Course Type: **Discipline Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the earth, its structures, rocks and its strength, natural disasters and water resources.
- To introduce the fundamental concepts relevant to selection of sites, stable foundation and underground construction.
- To enable the students to understand the natural factors that causes the instability of mega engineering structures.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction:** Dynamic Earth; Origin, Age, Interior, Materials of Earth; Silicate Structures and Symmetry Elements, Physical properties, Formation of Rocks; Igneous, Sedimentary and Metamorphic processes and structures, Characterisation; Weathering Processes; Geological Work of Rivers, Glaciers, Wind and Sea/Oceans, Deposits and Landforms; Formation of Soils; Engineering Properties of Rocks; Rock as Construction Material, Structural Features, Attitude of beds, True and apparent dips, Folds, Joints, Faults, Unconformities, Plate tectonics; Plate tectonics, Continental drift and sea floor spreading, Geological time scale, topographic maps, outcrops. Three point problems, Depth and thickness problems.	**10L**
UNIT-02	**Hydrogeology:** Ground water, zone of ground water, water table and perched water table, water bearing properties of rocks, occurrence of ground water, springs, selection of sites for well sinking and geophysical investigations (Electrical and Seismic methods).	**05L**
UNIT-03	**Earthquake and landslides:** Classification, causes and effects of earthquakes and landslides, seismic curve, seismograrphs, seismograms, accelograms, seismic problems of India, seismic zones of India, remedial measures to prevent damage for engineering structures, case histories.	**03L**
UNIT-04	Geology of dams and reservoirs: Types of dams, requirements of dam site, preliminary and detailed geological investigations for dam site, failures of dams and their causes, factors affecting seepage and leakage of the reservoirs and he remedial measures, silting of reservoirs.	**06L**
UNIT-05	**Rock Mechanics**: Rock Mechanics and its relationship with soil mechanics and engineering geology, application of rock mechanics to civil engineering problems. Index properties, Strength and failure criteria for rocks and rock masses, Insitu stresses in rocks and their measurement. Strength and deformation behavior of discontinuities in rocks. Deformation behaviour of rocks and rock masses. Time dependent behaviour of rocks. Application of Rock mechanics to Underground Structures, Slopes and Foundations. Improving the properties of insitu rock masses. Rockmass classifications, Terzaghi, RQD, RSR, RMR and Q classifications, Rating, Applications. Creep and cyclic loading. Weathered rocks.	**08L**
UNIT-06	**Tunneling:** Purpose of tunneling and geological problems connected with tunneling, Basic design and Principles of tunnels in rocks, Types and design of tunnel lining.	**04L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify the relevant construction material and project site for construction.
CO2: Describe the suitability of material and sites for construction.
CO3: Apply principles of natural processes on and within the earth.
CO4: Assess the impact of natural forces on civil engineering structures and other such projects.

Books and References:

1. Engineering Geology by Parbin Singh.
2. Engineering Geology by A. Parthasarathy, V. Panchapakesan, R. Nagarajan.
3. Geological Engineering by Luis I. Gonzalez de Vallejo, Mercedes Ferrer.
4. Rock Mechanics for Engineers by B.P.Verma.
5. Rock Mechanics Design in Mining and Tunneling by Z.T. Bieniawski.
6. Practical H.B. for Underground Rock Mechanics by Rotterdam Rudd T.R. Stay, A.A Balkema Publishers.

Course Name: **Surveying**
Course Code: **CE-214**
Course Type: **Discipline Core**

Contact Hours/Week: 3L Course Credits: **03**

Course Objectives:

- To impart knowledge about the importance, objective and basic principles of surveying.
- To introduce the fundamental concepts of linear, vertical, and directional measurement and use of surveying equipment to collect data needed to develop topographical maps, traverses, and profiles.
- To enable the students to Collect, analyze, and adjust field measurements; create horizontal and vertical control networks; and prepare a topographic map

Unit Number	Course Content	Contact Hours
UNIT-01	Introduction to surveying: plane and geodetic surveys, errors in measurements, maps, scales, plotting accuracy, topographic maps	**03L**
UNIT-02	Linear measurements: Direct and indirect methods, Chain and tape measurements, Optical methods- tacheometers, Electronic methods- EDMs/Total Station.	**03L**
UNIT-03	Vertical Measurement: Levelling and Contouring.	**04L**
UNIT-04	Measurement of directions: Compass surveying, Theodolites surveying.	**04L**
UNIT-05	Traversing and Triangulation: Traverse adjustments, computation of coordinates, omitted measurements	**04L**
UNIT-06	Plane tabling	**02L**
UNIT-07	Curves: Simple circular curves and Vertical curves	**04L**
UNIT-08	Earthwork: Area of traverse, Area and Volume of X-section, Mass Haul diagram	**04L**
UNIT-09	Modern Surveying methods: Aerial Photogrammetry, GPS, Remote sensing, GIS.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1 Acquire a sound and fundamental understanding of the scientific, mathematical, and engineering principles underlying surveying;

CO2 Understand and use surveying equipment ordinarily employed in surveying practice

CO3 Design the appropriate combination of equipment and procedures for a data-gathering task that will ensure that the gathered data meets the quality requirements of relative positioning.

Books and References:

1. Surveying–Vol 1 & 2 by K.R.Arora.
2. Plane Surveying by A. M.Chandra.
3. Engineering Survey by W. Schofield.
4. Surveying: Theory and Practice by J.M. Anderson and E.M. Mikhail.

Course Name: **Fluid Mechanics Lab**
Course Code: **CE-215**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives:

- To compare the results of analytical models introduced in lectures to the actual behavior of real fluid flows.
- To discuss and practice standard measurement techniques of fluid mechanics and their applications.
- To learn and practice writing technical reports and enable the students to work on small design projects.

List of Experiments:

1. To determine the metacentric height of a ship model.
2. To Verify Bernoulli's theorem.
3. To calibrate a venturi-meter and to determine its coefficient of discharge.
4. To calibrate an orifice meter and to determine its coefficient of discharge.
5. To study the flow over V-notch (weir) and rectangular notch and to find their coefficient of discharge.
6. To determine the coefficient of discharge of a mouthpiece.
7. To determine the coefficient of friction of pipes of different diameters.
8. To determine the form losses in a pipeline.
9. To obtain the surface profile on the total head distribution of a forced vortex.
10. To obtain the surface profile on the total head distribution of a free vortex.
11. Flow measurement using Rotameter.
12. To verify Darcy's law.

Note: The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify and characterize flow patterns and regimes.
CO2: Demonstrate practical understanding of principles, equations, and instruments of fluid flow related phenomena. CO3: Discuss the differences among measurement techniques, their relevance, and applications.
CO4: Demonstrate the ability to produce a working model through hands-on experience in fluid mechanics design.
CO5: Demonstrate the ability to write clear lab reports and understand ethical issues associated with decision making and professional conduct.

Course Name: **Surveying Practice**
Course Code: **CE-216**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives:

- To provide skills for using surveying equipment ordinarily employed in surveying practice

List of Experiments:

1. To determine the difference in elevation of two given points.
2. Profile levelling and cross-sectioning of a given route.
3. To measure the horizontal angle by the method of reiteration and repetition, theodolite traversing and error adjustment.
4. To prepare the contour map of an area by the method of radial lines.
5. Plane tabling by the method of radiation and intersection.
6. Basic settings of Total station
7. Topographic survey using a total station.
8. Setting out of simple circular curve by offsets from the long chord, successive bisection of long chord, radial and perpendicular offsets from the tangent.
9. Setting out of simple circular curve by one theodolite, two theodolite and total station method.
10. GPS/DGPS basic settings and survey

Note: The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of the semester based on the above generic list.

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1 Carry out the field surveying using a combination of different surveying equipment.
CO2 Plan a topographic survey and prepare a topographic map of an area.

Course Name: **Computer Aided Drafting Lab**
Course Code: **CE-217**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide skills for drafting simple building drawings.
- To enable the students to handle problems using general purpose softwares like AutoCAD.

List of Experiments

- Introduction to various CAD commands with simple examples.
- Line diagrams of different structures.
- Isometric exercises.
- Doors and Windows
- Calculation of area of closed traverse.
- Plan, section and elevation of residential building.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Prepare section, plan, and elevation of a building.

Course Name: **Indeterminate Structures**
Course Code: **CE-221**
Course Type: **Discipline Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives:

- To impart knowledge about the analysis of the statically and kinematically indeterminate structures
- To enable the students to understand the factors that cause such behavior of the indeterminate structure.
- Use different analytical tools for understanding the behaviour of statically indeterminate structures using force methods.
- Determine bending moment, shear force and axial force in the frames subjected to lateral and vertical loads using approximate methods.PLASTIC
- Use different analytical tools for understanding the behaviour of statically indeterminate structures using displacement methods.
- Carry out plastic analysis of beams and portal frames by equilibrium and mechanism methods.

Unit Number	Course Content	Contact Hours
UNIT-01	**Degree of static and kinematic indeterminacies** - introduction to force and displacement methods	**04L**
UNIT-02	**Statically indeterminate structures: Force methods**, Fixed and continuous beams: Fixed and continuous beams - force method - analysis by consistent deformation method - shear force and bending moment diagrams - deflection and support settlement. Indeterminate Frames and Trusses: Deflection of rigid frames of different geometry by consistent deformation method - settlement effects - analysis of trusses by consistent deformation method - externally and internally redundant trusses - effects of support settlement and pre-strains. Three-moment equation,	**10L**
UNIT-03	**Approximate methods of analysis of multi-storey frames:** Analysis for vertical load - substitute frames - loading condition for maximum positive and negative bending moment in beams and maximum bending moment in columns - analysis for lateral load - portal method - cantilever method.	
UNIT-04	**Kinematically Indeterminate Structures, Displacement method of analysis of indeterminate structures:** Slope deflection method - analysis of continuous beams - beams with overhang - analysis of rigid frames - frames with sloping legs - gabled frames - frames without sway and with sway -settlement effects - moment distribution method as successive approximation of slope deflection equations - analysis of beams and frames - non-sway and sway analyses-prestrain and temperature effects, Kani's Method.	**10L**
UNIT-05	**Two Hinged Arches:** Determinations of horizontal thrust, bending moment, normal thrust and radial shear for parabolic and segmental shapes, Influence lines for two hinged arches - effect of rib shortening - temperature effects - tied arches. **Influence lines for In-determinate structures**: Muller-Breslau Principle for Influence lines diagram of indeterminate structures: Beams, frame, trusses and three and two hinged & fixed arches.	**8L**
UNIT-06	**Plastic Analysis:** Plastic theory - introduction - plastic hinge concept - plastic modulus - shape factor -redistribution of moments - collapse mechanism - plastic analysis of beams and portal frames by equilibrium and mechanism methods.	**8L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify the load displacement response of the indeterminate structures.

CO2: Describe the bending moment, shear force and axial force variations along with the curvature, slope and deflection of the indeterminate structures.

CO3: Apply principles of basic structural analysis.

CO4: Assess the response of structure to the different types of loads.

Books and References:

1. Structural Analysis by R.C.Hibbeler, Pearson.
2. Fundamentals of Structural Analysis by K.M.Leet,C.MingUan, G &A.M.Gilbert,Tata McGraw Hill Education.
3. Structural Analysis by DevdasMenon, Narsoa.
4. Theory of Structures Vol-I&II by G.S.Pandit,S.P.Gupta&R.Gupta, Tata McGraw Hill Education.
5. Structural Analysis by L.S.Negi&R.S.Jangid, TATA McGraw Hill education.
6. Theory of Structures by S.Ramamrutham&R.Narayan, DhanpatRai& Son.
7. Basic Structural Analysis by C.S.ReddyTATA McGraw Hill education.
8. Theory of Structures by B.C.Punmia.Ashok Kumar Jain&Arun Kumar Jain, Laxmi
9. Structural Analysis I&II by S.S.Bhavikatti,Vikas.

Course Name: **Water Resources Engineering-I**
Course Code: **CE-222**
Course Type: **Discipline Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the water resources and components of hydrological cycle.
- To introduce the fundamental concepts relevant to water budget, watershed, runoff estimation, hydrograph analysis, flood, and groundwater hydrology.
- To enable the students to understand the factors responsible for different processes in hydrological cycle.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction:** Hydrological cycle, Water budget equation, Watershed.	**04L**
UNIT-02	**Abstractions:** Precipitation- Types, Measurement, Computation of average rainfall over a basin, Evaporation, transpiration, infiltration, Φ-index, weather systems.	**06L**
UNIT-03	**Runoff:** Factors affecting, runoff computation, rainfall-runoff correlation, flow mass curve, flow duration curve. Stream flow measurement: measurement of velocity-current meters, floats, area velocity method, moving boat and slope area method, electromagnetic, ultra-sonic and dilution methods of, stage discharge relationship	**08L**
UNIT-04	**Hydrographs:** Flood hydrograph, base flow separation, Unit and S-hydrograph, Unit Hydrograph from simple and complex storms, synthetic and instantaneous unit hydrograph.	**06L**
UNIT-05	**Floods:** Flood discharge estimation, flood control, reservoir, and channel routing.	**06L**
UNIT-06	**Groundwater Hydrology:** Darcy's Law – concept and applications, Well Hydraulics – Steady and unsteady state.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify different problems related to hydrology and water resources.
CO2: Describe problems related to water budget, hydrological processes, hydrographs of complex storms, flood estimation and routing, and groundwater hydrology related problems.
CO3: Apply principles, theory, and equations to solve problems mentioned in CO2.
CO4: Assess the results obtained by solving above problems.

Books and References:

1. Engineering Hydrology by K. Subramanya,
2. Engineering Hydrology by Ojha, Berndtssson and Bhunia,
3. Water Resources Engineering by R.K. Linsley and J.B. Franzini, McGraw-Hill Inc, 2000.
4. S.K.Sharma by Design of Irrigation Structures,
5. Groundwater by H.M Raghunath
6. Grounwater Hydrology by B.R. Chahar.

Course Name: **Soil Mechanics**
Course Code: **CE-223**
Course Type: **Discipline Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the index and engineering properties of soils
- To introduce the fundamental concepts relevant to the behaviour of soils
- To enable the students to understand the factors that control the behaviour of the soils

Unit Number	Course Content	Contact Hours
UNIT-01	**Soil Properties:** Introduction of soil mechanics, rock mechanics and foundation engineering, soil formation, soil structure, clay minerals, soil map of India, basic definitions, phase diagram, water content, specific gravity, void ratio, porosity, unit weight, degree of saturation, weight volume relationships, density index, index properties of soil and their determination, classification of soils.	**08L**
UNIT-02	**Permeability and Seepage and Effective Stress:** Darcy's law and its validity, seepage velocity, discharge velocity, constant and variable head permeameter tests, pumping in & out tests, permeability of stratified soils, factors affecting permeability, Laplace's equation, flow net and its properties, seepage pressure, quick sand, exit gradient, piping, effective stresses in soil.	**06L**
UNIT-03	**Stress Distribution in Soil**:.Stress distribution in soil, assumptions in elastic theories, Boussinesq's equation for point, line, circular and rectangular loads, Westergaad's formula for point load, comparison of Boussinesq's and Westergaard's equations, concept and use of pressure bulbs, principle and use of New mark's influence chart, Approximate stress distribution methods for loaded area, contact pressure.	**03L**
UNIT-04	**Compaction:** Mechanism of compaction, objective of compaction, measurement of compaction, factors affecting compaction, optimum moisture content, Standard Proctor test, Modified Proctor test, effect of moisture content and compactive effort on dry density, zero air void curve, relative compaction.	**03L**
UNIT-05	**Consolidation:** Mechanism of consolidation, basic definitions, types of consolidation, estimation of pre consolidation pressure, normally consolidation and over consolidation ratio, Terzaghi's theory of one-dimensional consolidation, laboratory determination of consolidation properties of soil, magnitude and rate of consolidation, compression characteristics of clays, settlement analysis.	**05L**
UNIT-06	**Shear strength:** Normal, shear and principal stresses, Columb's equation, Mohr's stress circle, Mohr-Columb failure criteria, laboratory determination of shear parameters of soil by direct shear tests, triaxial tests, unconfined compression test and vane shear test, pore pressure parameters, Stress Path.	**05L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify index properties of soil and to classify the soils.
CO2: Describe the behaviour of the soils.
CO3: Apply principles of soil mechanics to civil engineering problem.

Books and References:

1. Basic and applied soil mechanics by Gopal Ranjon & ASR Rao, New Age International Pvt Ltd Publishers.
2. Principles of Geotechnical Engineering by Brij Mohan Das, CENGAGE Learning.
3. Soil Mechanics and Foundations by B.C. Punmia, Laxmi Publications, New Delhi.
4. Geotechnical Engineering by C.Venkatramaiah, New Age International Publishers, New Delhi.
5. Principles of soil mechanics Addison-Wesley by Ronald F. Scott, Massachusetts.
6. Soil mechanics: Principles and Practice by Graham Barnes, Palgrave Macmillan, New York.
7. Modern Geotechnical Engineering by Alam Singh, Cbs Publishers & Distributors.

Course Name: **Building Materials and Construction**
Course Code: **CE-224**
Course Type: **Discipline Core**
Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the building material and construction
- To introduce the fundamental concepts relevant to properties of building materials and it application
- To enable the students to understand the factors that differentiate the building materials and accordingly its application

Unit Number	Course Content	Contact Hours
UNIT-01	**Building Stones:** Classification of stones- Characteristics of good building stones, important types of building stones, their properties and stones and uses. **Brick and other Clay Products:** Composition of brick-earth, manufacturing process of bricks, characteristics of good building bricks, classification and testing of bricks, special types of bricks and their uses. Types of tiles and their use in buildings. Terracotta, stoneware, properties and uses, Classification, tiles. **Limes:** IS Classification, properties and uses. **Cement:** Composition, manufacture, classification, and applications., properties and IS specifications and tests, rate of hydration, special types. **Fine and Coarse aggregate:** Source, Impurities, Classification, and Characteristics. Sand - properties; **Timber and Wood Based Products:** Classification of timber trees, cross section of exogenous tree, hard wood and soft wood, Classification, seasoning, defects, wood product and its applications. seasoning and preservation, Industrial timber products – manufacture and properties, ply wood and its uses,	**10L**
UNIT-02	**Ferrous and Non-Ferrous Metals and Alloys:** Mechanical & physical properties of ferrous metals, Aluminum and Copper. **Transformed Material** - Mortars: classification and uses, characteristics, functions of ingredient, **Cement concrete and Special concrete:** Types, Properties of fresh and hardened concrete, test methods, proportioning of concrete mixes; Concrete construction - batching, mixing, placing, compacting and curing of concrete, form work; Precast concrete and pre-stressed concrete; Recent developments in concreting; Iron and steel - Structural sections, properties and uses of structural steel; Recent developments in steel and concrete.	**8L**
UNIT-03	**Structural Components of building and building specification:** **Foundation:** Timbering of foundation trenches, bearing capacity of soils, improvement of bearing capacity, settlement of foundation; Type, application, Description of spread, grillage, raft and pile foundations. **Masonry Construction:** Masonry construction using stones, bricks, and other building blocks. Specifications for building stone, commonly used stones in masonry construction. Testing and preservation of stones. Manufacturing of clay bricks and their classification, Properties of clay bricks and their testing, Problems of efflorescence and lime bursting in bricks and tiles. Bonds in masonry construction. Types, Bonds, defects. Different types of mortars used in masonry construction. Factors affecting strength of masonry. Cavity wall, hollow block construction, Fal G bricks and other green construction building blocks. **Walls:** Design Consideration, constructional details, types of load bearing and non-load bearing walls, Cavity walls; Partition walls. **Floor and Roofs:** type, Ground/Upper: Flat /Slopped. Beam/Band-Plinth, Sill, Lintel -Types and details, Stairs, Ramps - classification, application; **Form work:** Requirements, Load applied, Scaffolding. **Lintels and arches Floors and roofs- different types – flooring and roofing materials ; Doors, windows & ventilators:** Different types of doors, windows & ventilators. Ventilation: Functional requirement, Systems	**15L**
UNIT-04	**Non-Structural Components of building and building specification** **Building Finishes and Maintenance:** Plastering, pointing, Distempering, Color washing, and Painting. Polymers, Plastic, Paints and Varnishes. Glass and insulating materials. Preventive maintenance Principles & Methods. Useful life of buildings. **Damp proofing anti- termite treatment and Water Proofing**: Causes, Prevention Methods, damp-proofing treatment, Materials used; Roof treatments for water proofing. **Termite Proof:** Materials used and Method of application.	**07L**

	Fire Protection: Fire safety requirement, fire extinguishing equipment. **Thermal Insulation:** Basic definitions, Materials used methods. Acoustics & Sound Insulation: characteristics, sound insulation, acoustical design. Roof treatments for thermal insulation and water proofing.	

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify and Describe construction material, structural and non-structural components
CO2: Apply principles of compatibility of material and construction methods
CO3: Assess the suitability and functional aspect of the materials and construction methodology
CO4: Identify various tests that are required for the quality assurance of materials in construction projects

Books and References:

1. Building Materials by S.K. Duggal, New Age Int. Publishers.
2. Building Materials by P.C.Varghese, PHI
3. Engineering Materials by R.K. Rajput, S. Chand Publishers
4. Building Construction by B.C.Punmia Ashok Kumar Jain &Arun Kumar Jain, Laxmi Publication
5. Rangwala, S. C., Engineering Materials, Charotar Publishing House, 1992.
6. Huntington, W.C., Building Construction, John Wiley, New York,1959
7. Shetty, M. S., Concrete Technology, S.Chand& Co., New Delhi, 1992.

Course Name: **Building Materials Lab**
Course Code: **CE-225**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives:

- To provide skills for testing of materials
- To developed understanding of Indian Standard for testing of materials
- To enable the students to carry out good construction practice

List of Experiments:

Tests on aggregate for concrete (Fine and Coarse Aggregate)
(a) Grain size distribution (b) Specific gravity (c) Density (d) Voids (e) Bulking
(f) Aggregate crushing value (g) Aggregate impact value (f) Water Absorption

Tests on cement:
(a) Fineness (b) Standard consistency (c) Initial and Final Setting time
(d) Compressive strength (d) Specific gravity(e) Soundness

Test for Fresh &Hard Concrete:
Workability Test (Slump Test, Compaction Factor Test, Vee Bee Test), Cube and Cylinder Strength of Concrete.
To design a concrete mix of given specifications and to evaluate associated trial mixes.

Tests on bricks& Stone:
Compressive (Crushing) strength, water absorption and efflorescence, dimensional tolerance and warpage in burnt clay bricks.

Note: The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify the various test procedures carried out for a building materials
CO2: Design and develop the materials for construction
CO3: Determine appropriateness of the material
CO4: Integrate the hands-on experience on material testing with their theoretical understanding of mechanical behaviour of materials.
CO5: Prepare reports and present the results based on the test data complying to the codes/regulations.
CO6: Refer codes and other reference materials for standard property data.
CO7: Interpret the results and recommend the suitability of a material for a given load case.

Books and References:

1. Neville, A. M., Properties of Concrete, Pitman, 1987.
2. Shetty, M. S., Concrete Technology, S I Chand and Company, 1993.
3. Timoshenko, S.P., Strength of materials, CBS publishers Pvt. Ltd., 1988.
4. Relevant BIS Standards

Course Name: **Structural Analysis Lab**
Course Code: **CE-226**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives:

- To impart concepts and skills of structural Analysis
- To introduce the fundamental concepts of analysis of determinate structures and validation of the experimental results with the theoretical results
- To enable the students to understand the skills and concepts of analysis of structures

List of Experiments

1. To verify the Betti's Law& Maxwell law of reciprocal displacements.
2. Study of a three hinged arch experimentally for a given set of loading and compare with analytical results.
3. To obtain experimental influence line diagram for horizontal thrust in a three hinged arch and compare with theoretical value.
4. To determine the flexural rigidity of a given beam.
5. To study the behavior of different type of struts.
6. To verify moment area theorem for slopes and deflections of a beams
7. To find the deflection of a pin-connected truss and to verify the results by calculation and graphically.
8. To determine the carry over factors for beam with rigid connections.
9. To determine the rotational stiffness of a beam when far end is (a) fixed (b) pinned.
10. Determine experimentally the horizontal displacement of the roller end of a two hinged arch for a given set of loading and to compare the results with those obtained analytically.
11. To obtain experimental influence line diagram for horizontal thrust in a two hinged arch and compare with theoretical value.
12. To study tensile stress and strain on different materials

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify the conceptualize the fundamentals of analysis of determinate structures.
CO2: Analyze and determine slope and deflection of determinate trusses, beams, and frames.
CO3: Apply principles and algorithms for analysis of structures.
CO4: Assess the results obtained by solving theoretical problems and validating it experimentally

Course Name: **Soil Mechanics Lab** Course Code: **CE-227**	
Contact Hours/Week: 2P	Course Credits: **01**

Course Objectives:

- To provide skills for the determination of the properties of the soils

List of Experiments:

1. Visual Soil Classification and water content determination.
2. Determination of specific gravity of soil solids.
3. Grain size analysis of soil by sieve analysis.
4. Determination of liquid limit and plastic limit.
5. Determination of field dry density by core cutter method and sand replacement method .
6. Proctor's compaction test.
7. Determination of coefficient of permeability of soils.
8. Direct shear test on granular soil sample.
9. Unconfined compressive strength test.

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Students will be able to have the skill to determine the soil properties as per the codal provisions.

Course Name: **RCC Design**
Course Code: **CE-311**
Course Type: **Discipline Core**

Contact Hours/Week: 3L + 1T | Course Credits: **04**

Course Objectives:

- To impart knowledge about the analysis, behavior and design of simple structural elements.
- To introduce the fundamental concepts of design and detailing in the Reinforced cement Concrete.
- To enable the students to understand importance of design and detailing.

Unit Number	Course Content	Contact Hours
UNIT-01	**Design philosophies: Introduction to different design philosophies**- working stress method-ultimate load method -limit state method - characteristic strength – characteristic loads – design values – partial safety factors – limit state of collapse – limit state of serviceability. Type of loads and load combinations. **Materials:** Properties of concrete and reinforcing steel – stress strain curves.	**06L**
UNIT-02	**Flexure:** Types of cross sections – rectangular – singly reinforced – doubly reinforced – flanged sections – analysis at service conditions – modes of failure in flexure – under reinforced – over reinforced – balanced sections – limiting moment of resistance – strain compatibility method – IS code procedure – design for flexure. **Design of RCC Slabs:** Concept of yield line theory - Design of One and Two way slabs, Effect of edge conditions- Moment of resistance-Torsion reinforcement at corners- Design examples.	**15L**
UNIT-03	**Shear and Bond design of RCC:** Modes of failure in shear – critical sections – nominal shear stress-shear strength of concrete – design for shear –Behavior of RC beam in shear, shear strength of beam with and without shear reinforcement, Minimum and Maximum shear reinforcement, design of Vertical Stirrups-Bent-up bars- Limitation, Design of beam in shear using Limit state methods. Nature of bond between steel and concrete, Bond failure in RC- Check for bond resistance Development of bond stress in reinforcement, Concept of development length and anchorage, Design of RC section in bond and calculation of development length using Limit state methods. **Torsion:** modes of failure in torsion – design for torsion. **Design for Serviceability:** Concept of Serviceability- Deflection- Span to depth ratio-short term-Long term deflection due to Shrinkage, Creep- Cracking-Crack width calculation, Control of deflections and cracking	**10L**
UNIT-04	**Compression members:** classification – short and slender columns – types of cross sections - analysis and design of axially loaded columns -columns with uni-axial and biaxial eccentricity – interaction diagrams. **Design of RC Footings:** Types of footings– design of isolated and Combined footings, RC footings-Minimum depth of footing- Safe bearing capacity Design for Bending-Shear in One way and Shear in Two way- Transfer of load at base of column.	**8L**
UNIT-05	**Design of Staircases:** Types terms used, design of stairs spanning, horizontally & Longitudinally, Circular/spiral doglegged, Open well stair.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Develop an understanding of design philosophies, basic concepts, and principles of design, loading standards, materials, and behavior of individual structural members.

CO2: Design the individual components of the buildings, like beams, columns, slabs, footings, stairs, etc as per the Indian standards.

CO3: Design large structures integrating the principles of design and become familiar with professional and contemporary issues in design and detailing of reinforcement.

CO4: Read and execute the drawings and detailing of reinforcement for the designed structures in the field.

CO5: Expose the stakeholders to the various concrete design codes.

CO6: Acquire knowledge of limit state design with respect to limit state of collapse against flexure, shear, torsion and compression and limit states of serviceability

Books and References:

1. Limit state design of reinforced concrete by Varghese, P. C., Prentice-Hall, New Delhi
2. Reinforced concrete design by Pillai, S, Unnikrishna, Menon Devdas, Tata McGraw-Hill, New Delhi
3. Fundamentals of reinforced concrete design by M.L. Gambhir, Prentice-Hall, New Delhi.
4. Design of R.C.C. structural elements by S.S. Bhavikatti, New Age International Publishers, New Delhi.
5. Reinforced Concrete (Limit state design) by A K Jain:
6. Reinforced Concrete Structures by B.C. Punmia, Luxmi Publications
7. IS 456 2000: Code of Practice for Plain and Reinforced Concrete
8. Relevant BIS Codes. (IS 456, IS: 1343, SP 16)
9. Design of reinforced Concrete Structures by N Subramanian, Oxford university Press
10. Design of Concrete Structures by Arthur H Nilson, David Darwin, Charles W Dolan, Tata McGraw Hill
11. Reinforced Concrete Design by N Krishna Raju and R N Pranesh, New Age Publishers
12. Design of Concrete Structures, J N Bandopadhyay, PHI
13. Limit State Design of Concrete Structures by Ram Chandra and Virendra Gehlot, SP
14. Sinha, S. N., Reinforced Concrete Design, Tata McGraw Hill, New Delhi, 2005.

Course Name: **Water Supply and Treatment**
Course Code: **CE-312**
Course Type: **Discipline Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- Introduction to the Environment and its components.
- To Understand the necessity of environmental engineering.
- To Know the basic of water quality & the concept of implementing standards.
- How to forecast future population of an area.
- To Understand & analyze various requirements of water.
- To Understand & analyze various sources of water.
- To Analyze and design the intake structures.
- To Analyze in detail every component of a water treatment plant.
- To Analyze the concepts of pumps & pipelines in water supply
- To Analysis of water distribution system.
- To Understand all the requirements for house supply
- To understand and analyse all the concepts of water supply required for a rural area.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction:** Scope and importance of Environmental Engineering and Management - Introduction to Environmental pollution - Impact on human health -, Significant water quality parameters for Municipal Water Supplies. Standards and guidelines for Water Quality Parameter.	**06L**
UNIT-02	Demand and Sources of Water: Water demand - Population forecast - Water quality requirements - Sources and its yield for water requirements- Intake structures – Water quality parameters and their significance in domestic use.	**06L**
UNIT-03	**Water Treatment:** Design of treatment units such as aeration, sedimentation, coagulation and flocculation, filtration, Disinfection, water softening- Advanced water treatment methods.	**09L**
UNIT-04	**Water Distribution Systems:** Pumps and pumping system – Pipes - Pipe appurtenances - Testing of water main – Distribution reservoirs - Distribution methods - Pipe network analysis - Planning of water supply project	**09L**
UNIT-05	**Plumbing and Fittings for Water Supply:** House water connection, Design consideration for water piping system and storage of water in building.	**03L**
UNIT-06	**Rural Water Supply and Treatment:** Water demand and treatment techniques for rural area, water problems and remedial measures.	**03L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Understand the basic concepts and analyze the requirements of a water supply project.
CO2: Experimentally analyze the water quality of an area and understand the need of safe and pure water.
CO3: Design a water treatment plant and understand the application of various treatment techniques in a water supply project.
CO4: Plan a water distribution system including its design etc.
CO5: Understand the importance of environment and its application in our day to day life.

Books and References:

1. Water Supply Engineering by S.K. Garg, Khanna Publishers.
2. Water Supply & Pollution Control by Warren ViessmanJr, Mark J. Hammer &Elizabeth Perez, PHI
3. Water & Wastewater Technology by Mark J. Hammer & Mark J. Hammer Jr., PHI
4. Water Works Engineering by Syed R. Qasim, Edward M. Motley, GuangZhu,PHI
5. Processes for Water Quality Control by Weber W. Physicochemical Wiley-Interscience, New York, 1972.
6. Manual on Water Supply Treatment 3rd Ed by Ministry of Urban Development,Central Public Health&Environmental.

Course Name: **Highway Engineering**
Course Code: **CE-313**
Course Type: **Discipline Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives
- To impart knowledge about the Roadway development of India
- To introduce the fundamental concepts of roadway geometric designs and construction procedures
- To enable the students to understand the factors considered in pavement design

Unit Number	Course Content	Contact Hours
UNIT-01	Road Development and Planning: Highway planning and development in India, Classification of roads, Road patterns	**06L**
UNIT-02	Highway Location and Alignment: Ideal alignment and factors controlling, Engineering survey for highway location, Drawing and reports	**06L**
UNIT-03	Highway Geometric Design: Geometric design factors, Highway cross-section elements, Sight distances, Design of horizontal alignment, Design of vertical alignment.	**06L**
UNIT-04	Pavement Materials: Soil characteristics and tests, soil stabilization, aggregate characteristics and tests, bituminous materials, cement	**06L**
UNIT-05	Pavement Design: Design factors, Design of flexible and rigid pavements by IRC method	**06L**
UNIT-06	Road Construction and Maintenance: Construction of flexible and rigid pavements, Pavement failures, maintenance techniques and recycling, evaluation and strengthening of existing pavements, New technologies such as FDR, CTB, cold mix etc.	**06L**

Course Outcomes
Upon successful completion of the course, the students will be able to
CO1: Design the cross-sectional, horizontal, vertical and intersection elements of roadway
CO2: Estimate the roadway capacity
CO3: Design pavement layers

Books and References
1. Highway Engineering by Khanna, S. K. & Justo, C. E. G., Nem Chand & Bros, Roorkee, U.K., India.
2. Traffic Engineering and Transport Planning by Kadiyali, L. R., Khanna Publishers.
3. Highway and Traffic Engineering, Saxena, S. C., CBS Publishers and Distributors.

Course Name: **Highway Engineering Lab**
Course Code: **CE-314**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives:

- To provide skills for testing coarse aggregates used in road construction.
- To provide skills for testing bitumen used in road construction.
- To provide skills for conducting different traffic studies

List of Experiments:

1. To determine the impact value of aggregate sample
2. To determine the crushing value of aggregate sample
3. To determine the flakiness and elongation index of aggregate sample
4. To perform Los Angeles Abrasion test on aggregate sample
5. To determine the CBR value of a given soil sample
6. To carry out the grain size analysis of course and fine aggregates
7. To perform penetration test on bitumen sample
8. To determine the softening point of bitumen sample
9. To determine the specific gravity and water absorption of aggregate sample
10. To determine the ductility value of a bitumen sample
11. To determine the bituminous content in a bituminous mix.
12. To carry out traffic survey on a road stretch

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Conduct different tests on road construction materials like bitumen & coarse aggregate.
CO2: Identify weather a batch of materials is suitable for road constructions.
CO3: Measure traffic parameters in the field.

Course Name: **Environmental Engineering Lab-I**
Course Code: **CE-315**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives:

- To introduce students to how the common environmental experiments relating to water quality were performed.
- To Understand and use the water and wastewater sampling procedures and sample preservations.
- To test the sample with appropriate methods for given environmental problems.
- To interpret laboratorial results and write technical reports, and apply the laboratorial results to problem identification, quantification, and basic environmental design and technical solutions

List of Experiments:

1. To find the test and odor of a given sample of water.
2. To find the turbidity, color, pH, and conductivity of a given sample of water.
3. To find out total dissolved solid, settleable solids and suspended solids of the given sample.
4. To determine the carbonate, bicarbonate, and hydroxide alkalinity of a sample.
5. To find out the concentration of chlorides in the given sample of water.
6. To estimate the hardness of the given sample of water by standard EDTA method
7. To find the optimum amount of coagulant required to treat the turbid water by Jar Test.
8. To determine residual chlorine in a given sample of water.
9. To determine trace metals in drinking water.

Note: The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Perform common environmental experiments relating to water quality, and know which tests are appropriate for given environmental problems.
CO2: Statistically analyze and interpret laboratorial results.
CO3: Understand and use the water sampling procedures and sample preservations.
CO4: Demonstrate the ability to write clear technical laboratorial reports

Books and References:

1. Methods of Sampling and Test (Physical and Chemical) For Water and Wastewater (IS:3025).
2. Standard Methods for the Examination of Water and Wastewater: APHA, AWWA.
3. Chemistry for Environmental Engg and Science: C.N. Sawyer, P.L. McCarty & G.F. Parkin.
4. Eaton, A. D. Standard Methods for the Examination of Water and Wastewater.

Course Name: **Foundation Engineering**
Course Code: **CE-321**
Course Type: **Discipline Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives:

- To impart knowledge about the stability of slopes, earth pressure, retaining structures, shallow and deep foundations.
- To introduce fundamental concepts relevant to slope stability, earth pressure, retaining structures, soil exploration, analysis of shallow and deep foundations.
- To enable the students to assess the stability of slopes and earth pressure, design of retaining structures, bearing capacity of shallow and pile foundations.

Unit Number	Course Content	Contact Hours
UNIT-01	**Stability Analysis:** Stability of finite and infinite slopes, types of failure, different factors of safety, determination of factor of safety by method of slices, Swedish circle, friction circle and Bishop' method, Taylor's stability number, location of critical circle.	**03L**
UNIT-02	**Earth Pressure:** Different types of earth pressure, Rankine's theory and Coulomb's theory, influence of water table, surcharge, wall friction and deformation on earth pressure, application of Rankine's theory and Coulomb's theory to cohesionless and cohesive soils..	**03L**
UNIT-03	**Retaining structures:** Failure modes of retaining walls, types of retaining walls, stability and design of retaining walls, types and stability of sheet pile walls.	**05L**
UNIT-04	**Soil Exploration:** Types of explorations, methods of boring, soil samples and sampling, depth of exploration, groundwater observation, penetration tests (SPT, CPT & DCPT).	**03L**
UNIT-05	**Foundations:** Different types of loads on foundations, types of foundations, selection of foundation type, location and depth of foundations, criterion of foundation design, modes of bearing capacity failure, determination of bearing capacity of shallow foundation using Terzaghi's theory, IS code method, plate load test and standard penetration test, settlement analysis of shallow foundations.	**08L**
UNIT-06	**Deep foundation:** Types of deep foundations, types of pile based on function, materials and methods of construction, friction and end bearing piles, determination of load carrying capacity of pile foundation using static formulae, Engineering News and Hiley's formula, group action and block failure of piles, negative skin friction, settlement of pile groups in clays, elements of well foundation, forces on well foundations, problems in sinking of wells and remedial measures.	**08L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: To learn slope stability analysis and different methods of determining the factor of safety of slopes.
CO2: To assess the lateral earth pressure in soil, and to determine stability of retaining walls and sheet pile walls.
CO3: To know the different types of methods of soil exploration.
CO4: To estimate the ultimate bearing capacity of shallow foundations and their settlement behavior.
CO5: To determine pile load capacity and elastic settlement of pile groups.
CO6: To understand the well foundation types, problems in sinking of wells and remedial measures.

Books and References:

1. Priciples of Foundation Engineering by B.M. Das.
2. Basic and applied soil mechanics by Ranjan and Rao
3. Geotechnical Engineering by C. Venkatramaiah.
4. Soil Mechanics & Foundation Engineering. by Purushotam Raj.
5. Design of Sub-Structures by Swami Saran.

Course Name: **Wastewater Treatment and Management**
Course Code: **CE-322**
Course Type: **Discipline Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To Estimate the sewage generation rate.
- To Analyze the sewage quality and its importance.
- To Design of a sewage treatment unit primary, secondery & tertiary.
- To Understanding various environment friendly low-cost sewage disposal techniques which can be generally used in rural areas.
- To Understand all the requirements for sewage disposal.
- To Analyze & design sludge treatment and disposal facility.

Unit Number	Course Content	Contact Hours
UNIT-01	Wastewater Generation, Collection & Conveyance: Wastewater Quantity - Classification of wastewater - Sewerage system for domestic wastewater and storm water - Collections, and appurtenances - Design and layout of sewerage systems - Maintenance of sewerage systems - Physical, Chemical & Biological characteristics and their significance.	**09L**
UNIT-02	Primary Treatment of Wastewater: Objectives of Wastewater treatment- Treatment methods: Unit Operations and Processes Design criteria -Design of primary treatment System.	**06L**
UNIT-03	Secondary Treatment of Wastewater: 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.	**09L**
UNIT-04	House Drainage & Environmental Sanitation: General principles - House drainage system – traps and sanitary fitting - Low-cost sanitation system.	**03L**
UNIT-05	Wastewater Disposal: Alternative disposal methods - Self-purification of stream - Standards for disposal alternatives, natural purification of polluted streams.	**04L**
UNIT-06	Sludge Handling: Quantity and quality of sludge, Methods of sludge treatment: sludge digestion and drying beds – Disposal of sludges.	**05L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Understand the basic concepts and analyze how to dispose of the sewage in an environment friendly manner.
CO2: Experimentally analyze the sewage quality of an area and understand the need of safe disposal of sewage.
CO3: Design a sewage treatment plant and understand the application of various sewage treatment techniques.
CO4: Plan an effective and efficient sewage disposal system for an area.

Books and References:

1. Sewage Disposal & Air Pollution Engineering by S.K. Garg,Khanna Publishers.
2. Wastewater Engineering by Metcalf & Eddy, McGraw Hill.
3. Wastewater Treatment Plants by Syed R. Qasim, PHI.
4. Wastewater Treatment Concepts & Design Approach by G.L. Karia and R.A. Christian, PHI.
5. Manual for Sewage Treatment by Ministry of Urban Development, Govt of India.

Course Name: **Water Resources Engineering -II**
Course Code: **CE-323**
Course Type: **Discipline Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the water resources and components of hydrological cycle.
- To introduce the fundamental concepts relevant to flow in open channels, GVF, RVF, energy dissipation, soil moisture, irrigation requirement, canals and water resources management.
- To enable the students to understand the factors responsible for different processes in open channel hydraulics and irrigation sciences.

Unit Number	Course Content	Contact Hours
UNIT-01	**Open Channel Flow:** Types of open channels, classification of flows, continuity equation, concept of specific energy, critical depth, Chezy's and Mannings equation, roughness coefficients, equivalent roughness, hydraulically efficient channel cross sections.	**08L**
UNIT-02	Gradually Varied Flow: Equations of GVF, Slope Profiles, Computations of GVF Profiles.	**02L**
UNIT-03	**Rapidly Varied Flow:** Hydraulic Jump – Concept and computations, Principles of energy dissipation, Jump as Energy dissipaters, tail water rating curve and jump height curves.	**06L**
UNIT-04	**Irrigation:** Water requirements of crops: Soil moisture and crop-water relations, Consumptive use of water, duty and delta, irrigation efficiencies, computation of channel and reservoir capacity based on crop water requirements, Irrigation methods, Irrigation scheduling.	**06L**
UNIT-05	**Canals:** Initiation of motion of Sediment, Canal classification, Design of stable channels, regime theory and design of unlined canals. Water logging: causes, preventive and curative measures.	**08L**
UNIT-06	**Water Resources Management:** Water resources availability and demand; Water use sectors – Domestic, Industries and Agriculture; Sustainable water resources development; Integrated Water Resources Management (IWRM).	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify different problems related to open channel flow and irrigation engineering.
CO2: Describe problems related to uniform flow, gradually and rapidly varied flow in open channels, water requirement of crops, irrigation scheduling, canal design and some aspects of water management.
CO3: Apply principles, theory, and equations to solve problems mentioned in CO2.
CO4: Assess the results obtained by solving above problems.

Books and References:

1. Engineering Hydrology by K. Subramanya.
2. Engineering Hydrology by Ojha, Berndtssson and Bhunia.
3. Fundamentals of Irrigation Engineering by Bharat Singh.
4. Water Resources Engineering by R.K. Linsley and J.B. Franzini, McGraw-Hill.
5. S.K. Sharma by Design of Irrigation Structures.
6. Irrigation Engineering and Hydraulic Structures by S.K. Garg.
7. Flow in open Channels by K. Subramanya.
8. Open Channel Flow by K.G. Rangaraju.

Course Name: **Structural Drawing Lab**
Course Code: **CE-324**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives:

- To develop skills for making drawing for structural detail.
- To developed understanding of convention.
- To enable the students to carry out construction of structural element with assistance of drawings.

List of design and drawing of various structural elements:

1. Fundamental Reinforced concrete Structures elements: Beam, column, slab, foundation detail.
2. Retaining wall: Counterfort retaining wall.
3. Water tanks: R.C.C. rectangular, overhead water tank with staging.
4. Fundamental Steel Structures elements: Typical connection details- welded and bolted, splice details, Lacing and battening, Flexural Beams, Column bases.
5. Roof trusses and connection details.
6. Plate girder and Gantry girder.
7. Bridge Superstructure: T beam bridge, Hollow girder deck bridge
8. Bridges Substructure: Bridge Piers, Abutment, wing wall and approaches, well foundation

Note: The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Developing knowledge about the convention used for generating drawing.
CO2: Converting the design parameter into drawing for construction.
CO3: Drawing based construction.

Course Name: **Environmental Engineering Lab-II**
Course Code: **CE-325**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives:

- To introduce students to how the common environmental experiments relating to wastewater were performed.
- To Understand the wastewater sampling procedures and sample preservations.
- To tests the sample with appropriate methods for given environmental problems.
- To interpret laboratorial results and write technical reports, and apply the laboratorial results to problem identification, quantification, and basic environmental design and technical solutions

List of Experiments:

1. To determine the pH of a given sample of sewage.
2. To determine total solid, settleable solids and volatile solids of sewage.
3. To find the quantity of dissolved oxygen (DO) present in the given sample.
4. To determine biochemical oxygen demand (BOD)
5. To determine Chemical oxygen demand (COD) of a given wastewater sample.
6. To determine the fates, grease and oil of a given sample of sewage.
7. To determine nitrogen, nitrites, and nitrate content in the given sewage.
8. To determine MPN of coliforms of the given sample.
9. To determine the metal & metalloids of the given sample.

Note: The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Perform common environmental experiments relating to wastewater, and know which tests are appropriate for given environmental problems.
CO2: Statistically analyze and interpret laboratorial results.
CO3: Understand the wastewater sampling procedures and sample preservations.
CO4: Demonstrate the ability to write clear technical laboratorial reports

Books and References:

5. Methods Of Sampling and Test (Physical and Chemical) For Water and Wastewater (IS:3025).
6. Standard Methods for the Examination of Water and Wastewater: APHA, AWWA.
7. Chemistry for Environmental Engg and Science: C.N. Sawyer, P.L. McCarty & G.F. Parkin.
8. Eaton, A. D. Standard Methods for the Examination of Water and Wastewater.

Course Name: **Steel Structure**
Course Code: **CE-411**
Course Type: **Discipline Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart concepts of design of steel structures.
- To introduce the fundamental concepts of design of tension, compression flexure members in steel structures, design of column bases plate girders and connections in steel structures.
- To enable the students to understand the factors that cause the design of steel structures

Unit Number	Course Contents	Contact Hours
UNIT-01	**Introduction:** General- Types of Steel – Mechanical behaviour of steel – Measures of Yielding – Measures of Ductility – Types of Structures – Structural Steel Sections. **Methods of Structural design:** Introduction-Design Philosophies-Working Stress method Ultimate Strength method-Load and Resistant factor- Limit State Method-Partial safety factor Load-Load combinations-Classification of Cross sections- General aspects in the design.	**06L**
UNIT-02	**Design of Steel Fasteners (Connections) in steel structures:** Bolted and welded connections, assumptions, Different types of joints, design of various types of bolted and welded connections subjected to direct loads and Eccentric Loads.	**10L**
UNIT-03	**Design of Tension members:** Selection of section, I.S. specifications, design of axially loaded tension members, design of members for axial tension and bending, end connections, design of lug angles and tension splices.	**05L**
UNIT-04	**Design of steel Compression members (**column and footings**):** Theory of buckling, Axially and eccentrically loaded compression members, design of column, cross section (single and built-up sections), design of angle struts, eccentrically loaded columns, column splices, lacings and battens. **Design of column bases:** Design of: Slab base, gusseted base, and Grillage Foundation subjected to Axial& Eccentric Loads.	**10L**
UNIT-05	**Design of steel Flexural Beam members:** Analysis and design of laterally restrained – unrestrained – simple and compound (built up) beams –deflection criteria - check for shear - open web girders – castellated beams, plated beams and curtailment of flange plates. **Design of Plate Girder and Gantry Girder:** Design of section, stiffeners, splices, design of Gantry Girder	**08L**
UNIT-06	**Design of Steel Roof systems:** Types of trusses, roofs and side coverage, types of loadings, wind load on truss – load combinations -design of roof trusses – design of roofing elements and purlin – wind bracings, Connections.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Identify the concept of design of steel structures.
CO2: Decide upon the type of structural steel connections and its design
CO3: Design the various components of steel structures like beam column, beam, truss etc.
CO4: Apply principles and algorithms for steel structures design

Books and References:

1. Design of Steel Structures by Subramanian,N, Oxford University Press, New Delhi
2. Design of Steel Structures by Duggal , S.K., Tata Mcgraw-Hill, New Delhi
3. Design of Steel Structures by Limit State Method As Per Is 800-2007, Bhavikatti,S.S., I.K.InternationalPublishing House, New Delhi
4. Limit State Design in Structural Steel by M.R.Shiyekar, PHI
5. Design of Steel Structures by K.S.Sai Ram, Pearson.
6. IS 800-2007 General Construction in Steel-Code of Practice, BIS
7. IS 801-1995 Use of cold deformed light gauge steel structural members in general BC.
8. Relevant BIS codes(IS 883 , IS 800, SP 6, IS 875)

Course Name: **Traffic Engineering and Transportation Planning**
Course Code: **CE-412**
Course Type: **Discipline Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To understand the fundamental traffic parameters and design criteria.
- To understand the steps involved in transportation planning.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction to traffic analysis:** Components and characteristics of traffic stream, Theories of traffic flow modeling- Poisson model, negative binomial and their limitations, Pedestrian facilities and flow characteristics	**08L**
UNIT-02	**Highway Capacity and Level-of-Service Analysis:** Design traffic volume, PHF, Concept of LOS, IndoHCM Vs US HCM,	**04L**
UNIT-03	**Traffic studies:** Speed and Traffic volume studies, Accident studies, Parking studies, OD studies	**06L**
UNIT-04	**Traffic control and Intersection design:** Traffic signs, road markings, Types of intersections and controls, Design of traffic rotaries, Signal design by Webster's method	**05L**
UNIT-05	**Transportation Planning and analysis:** Introduction to urban and regional transportation planning, Travel demand modeling- trip generation, mode and destination choice, highway route choice,	**08L**
UNIT-06	**Intelligent transportation systems:** Intelligent infrastructure, vehicle and user assistance systems, Congestion mitigation techniques, traffic calming etc.	**03L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand how to assess the health of structures using different techniques of SHM.
CO2: Identify suitable techniques for structural condition assessment.
CO3: Decide the appropriate strengthening & retrofitting techniques to regain the structural strength.

Books and References

1. C.S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, 3rd Ed., Prentice Hall, New Jersey, 2001.
2. J.H. Banks, Introduction to Transportation Engineering, McGraw-Hill, New York, 2002.
3. Fred L. Mannering, and Scott S. Washburn, Principles of highway engineering and traffic analysis.
4. S.K. Khanna and C.E.G. Justo, Highway Engineering, Khanna Publishers, Roorkee.
5. Highway Capacity Manual, Transportation Research Board, National Research Council, Washington, D.C, 2022".
6. L.R. Kadiyali, Principles and Practice of Highway Engineering, Khanna Technical Publications Indo-Highway Capacity Manual, New Delhi, 2019

Course Name: **Quantity Surveying and Estimating**
Course Code: **CE-413**
Course Type: **Discipline Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the quantity surveying
- To introduce the fundamental concepts relevant to estimation and costing
- To enable the students to understand the specifications

Unit Number	Course Content	Contact Hours
UNIT-01	**Estimate:** Principles of estimation, units, items of work, different kinds of estimates, different methods of estimation, estimation of materials in single room building, two roomed building with different sections of walls for foundation, floors, and roofs, R.B. and R.C.C. works, plastering, white-washing, distempering, painting, doors and windows, and lump sum items, estimates of canals and roads.	**09L**
UNIT-02	**Specification of Works:** Necessity of specifications, types of specifications, general specifications, specification for bricks, cement, sand, water, lime, reinforcement; detailed specifications for earthwork, cement, concrete, brick work, floorings, D.P.C., R.C.C., cement plastering, white and color washing, distempering, painting.	**09L**
UNIT-03	**Rate Analysis:** Purpose, preparation of rate analysis, procedure of rate analysis for items: - earthwork, concrete works, R.C.C. works, reinforced brick work, plastering, painting, white-washing, and distempering.	**08L**
UNIT-04	**Valuation:** Gross income, net income, outgoings, scrap values, salvage value, obsolescence, annuity, sinking fund, depreciation, valuations of buildings.	**05L**
UNIT-05	**Public Works Account:** Regular and work charge establishment, earnest money, security money, retention money, muster roll, measurement book, cash book, examination, and payment of bills, first and final bills, administrative sanction, technical sanction.	**05L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Estimate quantities in the various items of work in civil engineering.
CO2: Understand the specifications and their need in the civil engineering works.
CO3: Understand calculation of rates of various items of work in civil engineering.
CO4: Estimate the fair price or value of civil engineering property,
CO5: Understand the documentation in the public work departments.

Books and References:

1. Estimating & Costing in Civil Engineering: Theory and Practice by. B.N. Dutta.
2. Estimating and Costing for Building & Civil Engineering Works by P.L. Bhasin.
3. Costing & Specification in Civil Engineering by M. Chakarborty, Estimating.
4. Building Construction Estimating by George H. Cooper.

Course Name: **Hydraulics Lab**
Course Code: **CE-414**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives:

- To compare the results of analytical models introduced in lecture to the actual behavior of real fluid flows.
- To discuss and practice standard measurement techniques of fluid mechanics and their applications.
- To learn and practice writing technical reports and enable the students to work on small design projects.

List of Experiments:

1. To measure flow using electrical analogy method for flow net.
2. To verify Darcy's law.
3. To determine saturated hydraulic conductivity of soil.
4. To study various infiltration capacity models using infiltrometer.
5. To study the pressure distribution around sphere, aerofoil and cylinder placed in flowing fluid.
6. To study the use of various instruments for measuring parameters of hydrometeorology.
7. To study the characteristics of hydraulic jump in an open channel.
8. To study the boundary layer development on a flat plate.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify and characterize flow patterns and regimes.
CO2: Demonstrate practical understanding of principles, equations, and instruments of fluid flow related phenomena.
CO3: Discuss the differences among measurement techniques, their relevance, and applications.
CO4: Demonstrate the ability to produce a working model through hands-on experience in fluid mechanics design.
CO5: Demonstrate the ability to write clear lab reports and understand ethical issues associated with decision making and professional conduct.

Course Name: **Computational Lab**

Course Code: **CE-415**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide skills for designing flowcharts and writing algorithms
- To provide skills for analyzing and designing structural elements
- To provide skills for building drawing
- To provide skills for solving Geotechnical, Transportation Engg. and GIS related problems

List of Experiments

1. MATLAB - Fundamentals of Matlab Programming, Application to Engineering problems.
2. STAAD Pro -Modeling for truss, plane and space frames, loadings, Design
3. STRUDS – Modeling, analysis, and design of framed structures
4. ANSYS, SAP2000, & NISA – Modeling and analysis of structures using FEM
5. GEO 5, Plaxis 3D - Geotechnical problems that can be solved using software.
6. PTV VISSIM – To simulate Traffic Stream.
7. Q-GIS - Introduction to Geospatial Technology

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify and abstract the programming task involved for a given problem.
CO2: Design and analyze structural elements.
CO3: Solve Geotechnical, Transportation Engg. and GIS problems through software
CO4: Simulate a traffic stream based on given conditions

Department of Civil Engineering

Course Name: **Concrete Technology**
Course Code: **CE-241**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To understand the properties of ingredients of concrete
- To study about the concrete design mix
- To study the behaviour of concrete at its fresh and hardened state
- To know about the procedures in concreting
- To understand special concrete and their use

Unit Number	Course Content	Contact Hours
UNIT-01	**Properties and Strength of concrete in Fresh and Hard state**: Fresh concrete - workability, tests for workability, cohesion, segregation and bleeding; Hardened concrete- factors affecting strength of concrete, strength of concrete in compression, tension and flexure ; stress- strain characteristics and elastic properties ; Fresh and hardened properties of Concrete –Quality control -Sampling and testing-Acceptance criteria.	**08L**
UNIT-02	**Durability of concrete**: Creep and Shrinkage; Permeability ; Chemical attack ; Sulphate attack , Alkali – silica reaction ; Alkali -aggregate reaction ;Resistance to abrasion and cavitations ; Resistance to freezing and thawing ; Resistance to fire ; Marine atmosphere , quality control ; Frequency of sampling , test specimens , statistical analysis of test results ; standard deviation ; Acceptance criteria–Rebound hammer and Ultra-sonic pulse velocity testing methods, Non Destructive Testing of Concrete. **Mix Design:** factors influencing mix proportion -Mix design by ACI method and I.S. code method. design for high strength mixes	**12L**
UNIT-03	**Special concrete:** Lightweight concrete, High strength concrete; High performance concrete; Fibre reinforced concrete-polymer concrete; Ferro cement; Self compacting concrete; Hot and Cold weathering Concrete, Ready mix concrete Sustainability of concrete.	**07L**
UNIT-04	**Types of failure:** Diagnosis of distress in concrete; Crack control, leak proofing; Shotcrete; Guniting and jacketing techniques. **High Strength Concrete**: Microstructure – Manufacturing and Properties – Design of HSC Using Erintroy Shaklok method – Ultra High Strength Concrete. **High Performance Concrete**: Requirements and Properties of High-Performance Concrete Design Considerations. BIS Provisions. **Concrete Mix proportion guidelines:** DOE Method–LightWeight Concrete, Self-Compacting Concrete.	**07L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1. Select suitable materials for cement concrete construction.
CO2. Design a concrete mix proportion based on the requirements and make a proper concrete for construction purposes.
CO3. Determine the hardened properties of concrete and make a durable concrete.
CO4. Suggest suitable type of special concrete and diagnose the distress in concrete structures and apply remedial measures.
CO5. Design the concrete mix using ACI and IS code methods 3. determine the properties of fresh and hardened concrete.
CO6. Ensure quality control while testing/ sampling and acceptance criteria.
CO7. Design special concrete and their specific applications.

Books and References:

1. Neville, A. M., Properties of Concrete, Pitman, 1987.
2. P. Kumar Mehta, Concrete: Microstructure, Properties, and Materials, McGraw- Hill,2005
3. Shetty, M. S., Concreste Technology, S I Chand and Company, 1993.
4. Gambhir, M. L., Concrete Technology, Tata McGraw Hill, 1995.
5. Orchard, D. F., Concrete Technology Vol. I and II, 1968.
6. Krishna Raju, N., Design of Concrete Mixes, CBS publishers, 1988.
7. Raina, V. K., Concrete for Construction-Facts and Practices, Tata McGraw Hill publishing co. 1988.
8. John. H. Bungey, The Testing of Concrete in Structures, Urrey University of Press Hall
9. Akroyd, T. N. W., Concrete: Properties and Manufacture, Pergamon Press, 1962.
10. Mehta P. K. and Monterio P. J. M. (2017), Concrete: Microstructure, Properties, and Materials, 4th edition, McGraw Hill Education, USA.
11. IS 456 (2000), Plain and Reinforced Concrete - Code of Practice, Bureau of Indian Standards (BIS), New Delhi, India.
12. IS 10262 (2019), Concrete Mix Proportioning – Guidelines, Bureau of Indian Standards (BIS), New Delhi, India.
13. ACI 318 (2014), Building code requirements for structural concrete (ACI 318-2014) and Commentary (ACI 318R-2014). American Concrete Institute, Detroit, MI, USA.

Department of Civil Engineering

Course Name: **Remote Sensing**
Course Code: **CE-242**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the electromagnetic spectrum and its interaction with various earth surface features
- To introduce the fundamental concepts relevant to computer processing of remotely sensed imagery image
- To understand geographic information systems, data models in GIS, database management in GIS, spatial analysis and other GIS tools and techniques

Unit Number	Course Content	Contact Hours
UNIT-01	**Remote Sensing** - Basic concept, Electromagnetic spectrum, Spectral signature, Resolutions- Spectral. Spatial, Temporal and Radiometric, Platforms and Sensors, Remote Sensing Data Products - PAN, Multispectral, Microwave, Thermal, Hyperspectral, Visual and digital interpretation method	**03L**
UNIT-02	**Data Quantization and Processing -** Sampling and quantization theory, Principle of Linear System, Convolution, Continuous and Discrete Fourier Transform.	**04L**
UNIT-03	**Digital Image Processing** - Digital image characteristics: image histogram and scattergram and their significance, Variance-Covariance matrix, Correlation matrix and their significance.	**03L**
UNIT-04	**Radiometric and Geometric Corrections** – Registration and Resampling techniques.	**03L**
UNIT-05	**Image Enhancement** – Contrast Enhancement: Linear and Non-linear methods; Spatial Enhancement: Noise and Spatial filters	**03L**
UNIT-06	**Image Transformation** – Principal Component Analysis, Discriminant Analysis, Color transformations, Indices (Ratios, NDVI, NDWI, NDSI).	**03L**
UNIT-07	**Image Segmentation and Classification** – Simple techniques. Supervised and Unsupervised Classification, Accuracy assessment	**04L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1 Understand the concept of electromagnetic radiation, and its interaction with matter, particularly the land surface, the oceans, and the atmosphere to infer valid information from remote observations.

CO2 Apply the principles, techniques and practice of the quantitative analysis and image processing of digital satellite imagery.

CO3 To relate observations from remote sensing satellite data to models (mathematical, computational, and conceptual) and mapping.

Books and References:

1. Remote sensing and Image interpretation by T. M. Lillesand and R. W. Keifer.
2. Remote Sensing and GIS by B. Bhatta.
3. Fundamentals of Remote Sensing by George Joseph.

Department of Civil Engineering

Course Name: **Disaster Management**
Course Code: **CE-243**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the disaster Management …
- To introduce the fundamental concepts relevant to various aspect of disaster
- To enable the students to understand the factors that causes the disaster…

Unit Number	Course Content	Contact Hours
UNIT-01	**Understanding Disasters:** Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management Types, Trends, Causes, Consequences and Control of Disasters: Geological Disasters; Hydro-Meteorological Disasters, Biological Disasters and Man -made Disasters Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters	**06L**
UNIT-02	**Disaster Management Cycle and Framework:** Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro-zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical InfraSTure – Early Recovery – Reconstruction and Redevelopment; IDNDR, Yokohama Strategy, Hyogo Framework of Action	**12L**
UNIT-03	**Disaster Management in India:** Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter- Governmental Agencies	**06L**
UNIT-04	**Applications of Science and Technology for Disaster Management:** Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development Regulations Disaster Safe Designs and Constructions Structural and Non-Structural Mitigation of Disasters S&T Institutions for Disaster Management in India	**12L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify the types of disaster.
CO2: Describe disaster.
CO3: Apply principles of management
CO4: Assess the solution for handling disaster.

Books and References:

1. Manual on natural disaster management in India by M C Gupta, NIDM, New Delhi
2. Encyclopedia of disaster management, Vol I, II and IIIL Disaster management policy and Administration by S L Goyal, Deep & Deep, New Delhi,
3. Management of Natural Disasters in developing countries by H.N. Srivastava & G.D. Gupta, Daya Publishers, Delhi,
4. Disaster Management Act 2005, Publisher by Govt. of India
5. Publication of National Disaster Management Authority (PNDMI) on Various Templates and Guidelines for Disaster Management

Department of Civil Engineering

Course Name: **Groundwater Engineering**
Course Code: **CE-244**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To develop knowledge and understanding of flow in groundwater.
- To introduce the student to the principles of Groundwater governing Equations and Characteristics of different aquifers.
- To understand the techniques of development and management of groundwater.

Unit Number	Course Content	Contact Hours
UNIT-01	**Hydrogeological Parameters:** Introduction – Water bearing Properties of Rock – Type of aquifers – Aquifer properties – permeability, specific yield, transmissivity, and storage coefficient – Methods of Estimation– Ground water table fluctuation and its interpretations – Groundwater development and Potential in India.	**09L**
UNIT-02	**Well Hydraulics:** Objectives of Groundwater hydraulics – Darcy's Law – Groundwater equation – steady state flow – Dupuit's assumption – Unsteady state flow – Theis method – Jacob method -Slug tests – Image well theory – Partial penetrations of wells.	**09L**
UNIT-03	**Groundwater Management:** Need for Management Model – Database for groundwater management –groundwater balance study – Introduction to Mathematical model – Conjunctive use – Collector well and Infiltration gallery.	**09L**
UNIT-04	**Groundwater Quality:** Ground water chemistry – Origin, movement, and quality – Water quality standards – Health and aesthetic aspects of water quality – Saline intrusion – Environmental concern and Regulatory requirements.	**09L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Apply mathematical principles for the analysis of ground water flow problems.
CO2: Understand aquifer properties and its dynamics.
CO3: Understand design of well and solve practical problems of groundwater aquifers.
CO4: Understand the importance of artificial recharge and groundwater quality concepts.

Books and References:

1. Chow, V. T. (1959). Open-Channel Hydraulics. McGraw-Hill, New York, US.
2. Raghunath H.M., "Ground Water Hydrology", New Age International (P) Limited, New Delhi, 2010.
3. Bouwer, H. (1978). Groundwater Hydrology. McGraw-Hill, New York, US.
4. Fitts R Charles, "Groundwater Science". Elsevier, Academic Press, 2002.
5. Ramakrishnan, S, Ground Water, K.J. Graph arts, Chennai, 1998.

Department of Civil Engineering

Course Name: **Computational Fluid Dynamics**
Course Code: **CE-351**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To provide knowledge on application of computational fluid mechanics to different branch of engineering and science
- To provide knowledge on conservation law and the numerical approach to solve by converting different form of partial differential equation to algebraic equations.
- To provide some experience in the software engineering skills associated with the implementation of these techniques in practical MATLAB computer codes.
- To illuminate some of the difficulties like consistency, convergence and stability check that is encountered in the numerical solution of fluid flow problems.

Unit Number	Course Content	Contact Hours
UNIT-01	Introduction to Computational Fluid Dynamics, Application to different Branch of Science and Engineering, Governing equations for fluid flow: Continuity equation, momentum equation and energy equation.	**05L**
UNIT-02	Finite difference approach, Classification of partial differential equations, Parabolic, Hyperbolic and elliptic equations.	**05L**
UNIT-03	Discretisations of the 1-Dimensional, 2-Dimensional partial differential equations and its solutions. Finite difference formulations, Finite difference method: introduction, discretization methods, consistency, error and stability analysis, fundamentals of fluid flow modeling.	**07L**
UNIT-04	Finite difference applications, Solution of Navier-Stokes equation for incompressible flows using SIMPLE algorithm.	**05L**
UNIT-05	Explicit finite difference schemes, implicit finite difference schemes, Initial and Boundary conditions, significance of model boundary conditions, review of applied numerical methods.	**08L**
UNIT-06	Grid generation techniques, Von Neumann Stability analysis. Solution of Governing equations and Application to different fluid flow problems.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

1. Understand the governing equations based on conservation principals in fluid flow problems
2. Able to know the use of finite difference method applied to fluid flow problems
3. Able to check the output from numerical method as compared to the observed data

Books and References:

1. K. A Hoffmann, Computational Fluid Dynamics, Engineering Education System, 2000, Covers all FDM approaches with problems and solutions.
2. J.D. Anderson, Computational Fluid Dynamics, McGraw Hill, 1995, Covers the derivations of Continuity, momentum, and energy equations. FDM fundamentals and discretization approaches
3. M.B. Abbott and D.R. Basco, Computational Fluid Dynamics, Cambridge university press, Practical applications.
4. Vreugdenhil, Cornelis B, Computational Hydraulics An Introduction, Springer, Practical applications.

Department of Civil Engineering

Course Name: **Geographic Information System**
Course Code: **CE-352**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To understand the basics of geographic information systems
- To understand geospatial data database management in GIS
- Exposure to spatial analysis and other GIS tools and techniques

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction:** Evolution of GIS, Geo-spatial data: spatial and non-spatial, GIS Functions	**03L**
UNIT-02	**Coordinate systems:** Geographic coordinate systems, Map projections, Coordinate systems in GIS, Spatial referencing using coordinates and geographic identifiers	**04L**
UNIT-03	**Geo-Spatial Data:** Geospatial data models: raster and vector, metadata; Spatial data acquisition and input; Visualization of geospatial data, Data storage, RDBMS, database operations; Spatial and non-spatial data editing functions; Quality of spatial data	**06L**
UNIT-04	**GIS analysis and functions:** Retrieve, classify, measurement, neighborhood analysis, Terrain mapping and analysis, interpolation, overlay, buffering, join, relate, and query, network analysis, watershed/view shed analysis, pattern analysis	**10L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Explore maps, and create maps, images, and apps to communicate geo-spatial data in a meaningful way to others.
CO2: Develop and manage GIS database.
CO3: Analyze spatial data, using GIS analysis tools.

Books and References

1. Introduction to Geographic Information Systems by K.T. Chang
2. An Introduction to Geographical Information Systems by H. Ian.
3. Introductory Geographic Information Systems by J. Jansen and R. Jansen

Department of Civil Engineering

Course Name: **Air Pollution Control**
Course Code: **CE-353**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To understand the sources, characteristics, and effects of air pollutants
- To know the methods of controlling air pollution

Unit Number	Course Content	Contact Hours
UNIT-01	**Sources and effects of air pollutants:** Classification of air pollutants – Particulates and gaseous pollutants – Sources of air pollution – Source inventory – Effects of air pollution on human beings, materials, vegetation, animals – global warming-ozone layer depletion, Sampling and Analysis – Basic Principles of Sampling – Source and ambient sampling – Analysis of pollutants – Principles	**10L**
UNIT-02	**Dispersion of air pollutants:** Elements of atmosphere – Meteorological factors – Wind roses – Lapse rate – Atmospheric stability and turbulence – Plume rise – Dispersion of pollutants – Dispersion models – Applications.	**10L**
UNIT-03	**Air Pollution Control:** Concepts of control – Principles and design of control measures – Particulates control by gravitational, centrifugal, filtration, scrubbing, electrostatic precipitation – Selection criteria for equipment – gaseous pollutant control by adsorption, absorption, condensation, combustion – Pollution control for specific major industries	**16L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: understand the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management CO2: identify, formulate, and solve air and noise pollution problems.

CO3: design stacks and particulate air pollution control devices to meet applicable standards

Books and References:

1. Anjaneyulu, D., "Air Pollution and Control Technologies", Allied Publishers, Mumbai, 2002.
2. Rao, C.S. Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 1996.
3. Rao M.N., and Rao H. V. N., Air Pollution Control, Tata McGraw Hill, New Delhi, 1996.
4. Mahajan S.P., "Pollution Control in Process Industries", Tata McGraw Hill Publishing Company, New Delhi, 1991.

Department of Civil Engineering

Course Name: **Advanced RCC Structural Design**
Course Code: **CE-341**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To understand the design concept of various structures and detailing of reinforcements
- To understand the design of underground and elevated liquid retaining structures
- To study the design of material storage structures
- To know the effect of temperature on concrete structures
- To study the behavior and design of member subjected to combined forces.
- To calculate the wind forces on various types of structures.

Unit Number	Course Content	Contact Hours
UNIT-01	**Concrete storage structures:** **Earth Retaining structures** - Retaining walls- types - cantilever and counterfort - design - drainage and other construction details. **Liquid Retaining structure** - Water tanks - types - square, rectangular, circular - Design of underground and elevated tanks - design of staging - spherical & conical roof for circular tanks. **Material storage structures** - Determination of lateral pressure on side walls of bunker - Rankine's theory - design of bunker - design of circular silo using Jansen's theory. Environmental Structures - Chimneys - Principles and Design - Design of long columns.	**15L**
UNIT-02	**Concretes deep, tall and Shells and Folded plates structures:** **Design of Reinforced Concrete Deep Beams & Corbels:** Analysis of deep beams- design as per IS code - design using strut and tie method. Steps of Designing Deep Beams,Design by IS 456. Checking for Local Failures, Detailing of Deep Beams, Analysis of Forces in a Corbels, Design of Procedure of Corbels, Design of Nibs. Detailing of reinforcement. **Chimneys:** Analysis of stresses in concrete chimneys- uncracked and cracked sections- code provisions- design of chimney. **Shells and Folded plates:** Forms of shells and folded plates- structural behaviour of cylindrical shell and folded plate- method of analysis-membrane analysis – beam arch approximation- code provisions- design of simply supported circular cylindrical long shells and folded plates – Shear walls.	**15L**

Course Outcomes:

On completion of the course, the students will be able to:
CO1: Apply the concepts of liquid retaining structures.
CO2: Design material storage structures using various theories.
CO3: Demonstrate the detailing of reinforcement.
CO4: Calculate the wind load acting on various structures to be built in various locations.

Books and References:

1. Vazirani, V.N., and Ratwani, Concrete Structures, Vol. IV, Khanna Publishers, New Delhi, 1995.
2. Dayaratnam, P., Design of Reinforced Concrete Structures, Oxford & IBH Publishers & Co., New Delhi, 2005.
3. Raju N. K., Advanced Reinforced Concrete Design, CBS Publishers and Distributors Pvt. Ltd., India, 2016
4. Varghese P.C., Advanced Reinforced Concrete Design, PHI, India, 2nd Edition, 2010.
5. IS 456-2000 Code of practice for Plain and reinforced concrete code of practice.
6. IS875 Part (3) - 1987, Code of Practice for Design Loads (other than earthquake) for buildings and structures: Wind loads. Bureauof Indian Standards, New Delhi.
7. SP6 (1) - 1964, IS hand book for structural Engineers. Bureau of Indian Standards, New Delhi.
8. Design of Reinforced Concrete Structures by N.Subramanian, Oxford University Press.
9. Reinforced Concrete Design, by S. Unnikrishna Pillai & Devdas Menon Tata Mc. Graw-Hill Publishing Company Ltd. New Delhi 2010

Department of Civil Engineering

Course Name: **Reinforced Earth**
Course Code: **CE-342**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the design of civil engineering structures on reinforced earth
- To enable the students to learn field application of geosynthetic.

Unit Number	Course Content	Contact Hours
UNIT-01	**Analysis and design concepts**: Introduction, Design methodologies, retaining walls, Embankments, Shallow foundations, Roads, Railway tracks, Filters and drains, Slopes, Erosion control, Stabilization, Containment facilities, Landfills, Ponds, canals, Earth dam.	**13L**
UNIT-02	**Application guidelines**: Introduction, General guidelines, Care and consideration, Geosynthetic selection, Identification and inspection, Sampling and test methods, Protection before installation, Site preparation, Geosynthetic installation, Joints/Seams, Cutting of geosynthetics, Protection during construction and service life, Damage assessment and correction, Anchorage, Prestressing, Maintenance, Certification, Handling the refuse of geosynthetics, Specific guidelines related to Retaining walls, Embankments, Shallow foundations, roads, Railway tracks, Filters and drains, Slopes – erosion control, Slopes stabilization.	**08L**
UNIT-03	**Field Performance**: Field performance monitoring and Selected case studies.	**04L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Design the civil engineering structures on reinforced earth

Books and References:

1. Geosynthetics and Their Applications by S. K. Shukla and J.H Yin
2. Geotextiles and Geomembranes in Civil Engg- Gerard P.T.M. Van Santvrot, A.A. Balkema, Oxford and IBH publishing company, New Delhi.
3. Reinforced Soil and Geotextiles -J.N. Mandal, proceedings FIGC- 1988, Oxford and IBH publishing company private Ltd., New Delhi.
4. Geosynthetics: Application, Design and Construction- R.J. Tarmat, proceedings First Europian Geosynthetics Conference, Netherland. A. A. Balkema, Publisher-Brookfield, U.S.A.
5. Geosynthetics World -J.N. Mandal, Willey Eastern Limited, New Delhi

Department of Civil Engineering

Course Name: **Solid Waste Management**
Course Code: **CE-343**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- Understand the concept of waste management.
- Analyze the characteristics & Composition of waste.
- Analyze the waste generation rate.
- Analyze various methods of storage, collection, transport, treatment & disposal of waste.
- Understand the various ways in which we can reduce the volume of waste, recycle & reuse the waste for the benefit of the society.
- Understand the concept of hazardous waste management.
- Analyze the characteristics & Composition of hazardous waste.
- Analyze various methods of storage, collection, transport, treatment & disposal of hazardous waste.

Unit Number	Course Content	Contact Hours
UNIT-01	**Evolution of Solid Waste Management:** Introduction: Solid waste –A consequence of life Municipal Solid Waste: Generation, Rate Variation, Characteristics (Physical, Biological & Chemical);	**04L**
UNIT-02	**Engineering Principles:** Management Options for Solid Waste, Waste Reduction at the Source, Collection Techniques, Materials and Resources Recovery / Recycling.	**06L**
UNIT-03	**Waste Handling and separation:** Transport of Municipal Solid Waste, Routing and Scheduling, Treatment, Transformations	**06L**
UNIT-04	**Disposal of Solid waste and Residue matter:** Disposal Techniques (Composting, Vermi Composting, Incineration, Refuse Derived fuels, Landfilling).	**06L**
UNIT-05	**Sources, Types and Properties of hazardous Waste:** Hazardous Solid Waste: Generation, Rate Variation, Characteristics (Physical, Biological & Chemical);	**06L**
UNIT-05	**Hazardous Waste Management:** Hazardous waste management: Exposure and risk assessment, environment legislation, characterization and site assessment, waste minimization, incineration, transportation, storage, landfill disposal.	**08L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO 1: Understand the importance & basic concepts of waste management.
CO 2: Analyze how to dispose-off the waste in an environment friendly manner.
CO 3: Understand & analyze the concepts & importance of hazardous waste management.
CO 4: Understand & analyze the concepts of air pollution and its control techniques.
CO 5: Understand the importance of environment and need for its safety.

Books and References:

1. Iqbal H. Khan and Naved Ahsan, Text Book of Solid Wastes Management, CBS Publishers.
2. H.S. Peavy, D. R. Row and G. Tchobanoglous, Environmental Engineering, McGraw Hill.
3. Tchobanoglous, Theisen& Vigil, Integrated Solid Waste Management, McGraw Hill.
4. M. N. Rao & H. V. N Rao, Air pollution & Control, Tata McGraw Hill Publications.

Department of Civil Engineering

Course Name: **Watershed Development and Management**
Course Code: **CE-344**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To protect, conserve and improve the land of a watershed for more efficient and sustained production.
- To protect and enhance the water resources originating in the watershed.
- To moderate infiltration of rainwater and
- Provision for adequate supply of water for domestic, industrial, and agricultural needs.

Unit Number	Course Content	Contact Hours
UNIT-01	Concept of watershed development, objectives of watershed development, need for watershed development in India, Integrated and multidisciplinary approach for watershed management.	**07L**
UNIT-02	Characteristics of Watershed - size, shape, physiography, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology, socio-economic characteristics, basic data on watersheds.	**07L**
UNIT-03	Principles of erosion, Types of erosion, factors affecting erosion, effects of erosion on land fertility and land capability, estimation of soil loss due to erosion, Universal soil loss equation. Measures to Control Erosion, Contour techniques, ploughing, furrowing, trenching, bunding, terracing, gully control, rockfill dams, brushwood dam, Gabion.	**08L**
UNIT-04	Rainwater Harvesting, catchment harvesting, harvesting structures, soil moisture conservation, check dams, artificial recharge, farm ponds, percolation tanks. Conjunctive use of water.	**07L**
UNIT-05	Participatory Irrigation Management and Integrated Water Resources Management (IWRM), Water management policy during droughts. Predicting effect of water shortage on crops.	**07L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: To understand ecological and hydrological processes and concepts and apply them to watershed management actions such as harvesting, grazing, and restoration.

CO2: To will understand the history and policy that drives water management.

CO3: To apply assessment and classification tools to watersheds and their components to determine how management actions affect hydrologic responses.

Books and References:

1. Hydrology and the Management of Watersheds by Kenneth N. Brooks Peter F. Ffolliott Joseph A. Magner, John Wiley & Sons, Inc.
2. Integrated Watershed Management: Principles and Practice by Isobel W. Heathcote, John Wiley & Sons.
3. Watershed Management Guidebook by Kevin Drake and Michael Hogan, A Publication by Integrated Environmental Restoration Services, Inc.
4. Haan, C.T. “Hydrology of Small Watersheds”
5. Hillel, Daniel A. “Advances in Irrigation” Elsevier Science
6. Singh, Rajbir “Watershed Hydrology”
7. Singh, V.P. “Watershed Hydrology”
8. Schwaab, Frevert. “Soil and Water Conservation”
9. Suresh, R. “Land and Water Management Principles”

Department of Civil Engineering

Course Name: **Environmental Geo-Technology**
Course Code: **CE-361**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- Understand the Geoenvironmental issues at global, regional, and local levels.
- Identify the Sources of wastes and options available for waste management.
- Design and considerations of Landfill.
- Familiarize with the application of fly ash.

Unit Number	Course Content	Contact Hours
UNIT-01	**INTRODUCTION:** Introduction to environmental geo-technology, sources, production and classification of waste, liquid, solid and hazardous waste characterization, management and disposal options of solid waste, impact on environment.	**09L**
UNIT-02	**CONTAMINANT TRANSPORT, LANDFILL PLANNING AND DESIGN CONSIDERATION:** Introduction, Contaminant transport in subsurface, advection, diffusion, dispersion, landfill types, site selection for landfills, site characterization, landfill layout, landfill section, landfill capacity, planning of phased operation, leachate collection facility, gas collection facility, final cover, surface water drainage, stability aspects, environmental monitoring systems, construction schedule, material requirement, equipment requirement, environmental control during operation, landfill closure and post closure plan.	**12L**
UNIT-03	**UTILIZATION OF FLY ASH:** Geotechnical properties of fly ash, Problems in utilization, Present status and future need for bulk utilization of fly ash, Case studies.	**04L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Design of landfills
CO2: Handle the geo-environmental problem in actual practice.

Books and References:

1. Waste disposal in engineered landfills – Manoj Dutta
2. Geotextiles – Emerging Trends – G. Venkatappa Rao and K Balan
3. Geotechnical Engineering - C. Venkatramaiah

Department of Civil Engineering

Course Name: **Earthquake Resistant Design of Structures**
Course Code: **CE-362**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the Earthquake resistant construction
- To introduce the fundamental concepts relevant to designing lateral force resistant Construction
- To enable the students to understand the factors that cause the failure of structure during earthquake.
- To introduce the basics of Earthquake Engineering
- To introduce the engineering seismology, building geometrics & characteristics, structural irregularities,
- To introduce tips on earthquake engineering - do's and don'ts
- To introduce cyclic loading behaviour of RC, steel, and pre-stressed concrete elements
- To discuss code provisions and their application on different types of structures

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction to Engineering seismology:** Elements of Engineering Seismology Nature of earth ground motion - causes of earthquake - Indian Seismicity - Earthquake History - Behavior of structures in the past Earthquakes. seismic waves-primary and secondary waves – Raleigh wave - love wave – earthquake damage mechanism- magnitude of earthquake – intensity of earthquake- seismic zoning map of India-response of structure to earthquake motion. **Dynamic analysis:** Theory of vibrations, Seismic response of structures - Earthquake ground motions, inelastic seismic response – Conversion of Structures into equivalent mathematical model for vibration analysis, systems with single degree of freedom – systems with multiple degrees of freedom – continuous system – modeling of structures - Vibration of single, two and multi storey building frames – equation of motion – periods and modes of vibration - design spectrums – modal combination **Guide lines for seismic design:** Ductile detailing for seismic design - improving seismic behaviour of masonry, timber and steel buildings.	**12L**
UNIT-02	**Concept of seismic design**: Seismic design Philosophy Approach to seismic design – general principles of a seismic design - relevant IS codes – conceptual design- design earthquake loads-load combinations and permissible stresses - equivalent static analysis – vertical distribution of seismic forces and horizontal shears.	**08L**
UNIT-03	**Seismic Design Concepts** - Cyclic loading behavior of RC, Steel and Prestressed Concrete elements - Response Spectrum- Design spectrum - capacity based design. Provision of Seismic Code frames, shear walls, Braced frames, Combinations - Torsion. Performance of Regular Buildings 3D Computer Analysis of Building Systems (Theory only) - Design and Detailing of frames - Shear walls and Frame walls. Earthquake resistant Reinforced concrete buildings Codal provisions for design against earthquake IS: 1893-2016, IS: 13920-2016. Seismic performance - Irregular Buildings -Soil performance, Modern Concepts - Base Isolation - Adoptive systems - Case studies.	**10L**
UNIT-04	**Seismic design:** Seismic design of water tanks– elevated tower supported tanks-hydrodynamic pressure in tanks – examples-seismic design of towers – stack like structures – chimneys – seismic design principles of retaining walls – concept of seismic design of bridges – seismic design of bearings.	**12L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify earthquake resistant features.
CO2: Describe methodology to carry out earthquake resistant design and construction.
CO3: Apply principles of analysis and design
CO4: Assess the specific feature of earthquake resistant construction apply the basics of Earthquake Engineering
CO5: Demonstrate the dynamics of structural system under earthquake load.
CO6: Analyze the influence of the structural / geometrical design in building characteristics.
CO7: Demonstrate the cyclic loading behaviour of RC steel and pre-stressed concrete elements.
CO8: Apply Codal provisions on different types of structures

Books and References:

1. Earthquake resistant design of structuresbyAgarwal , Pankaj , Shrikhande , Manish ,Prentice-Hall, New Delhi.
2. Dynamics of structures: theory and applications to earthquake engineering by Chopra, Anil K., Prentice-Hall, New Delhi.
3. Elements of earthquake engineering by Krishna,Jai, South Asian Publishers, New Delhi.
4. IS: 1893 (Pt1) 2016, Criteria for earthquake resistant design of structures by Bureau of Indian Standards, New Delhi
5. IS: 4326-2013, Earthquake resistant design and construction of building-code of practice by Bureau of Indian Standards, New

Delhi.
6. IS: 13827 1993, Indian standards improving earthquake resistance of earthen buildings by Bureau of Indian Standards, New Delhi.
7. IS: 13828 1993, Improving earthquake resistance of low strength masonary buildings-guidelines by Bureau of Indian Standards, New Delhi.
8. Duggal, S. K., Earthquake Resistant Design of structures, Oxford University Press, 2007.
9. Datta, T.K., Seismic Analysis of Structures, John Wiley and sons (Asia) Pvt Ltd, 2010.
10. Brijesh, C., Chandasekaran, Krishna Jai, A.R., Elements of Earthquake Engineering, South Asian Publishers Pvt.Ltd, 1994.
11. Gupta, A., Response Spectrum Method in Seismic Analysis and Design of Structures, CRC press, INC, 1992.
12. Bullen K.E., Introduction to the Theory of Seismology, Great Britain at the University Printing houses, Cambridge University Press 1996.
13. SP 22: Explanatory Handbook on Codes for Earthquake Engineering.
14. Meirovitch L., Elements of Vibration Analysis, Mc.Graw Hill, 1986.
15. Thomson W.T., Theory of Vibration with Applications, Pearson Education Inc., 1998.
16. Hurty, W.C. and Rubinstein M.F., Dynamics of Structures, Prentice Hall, 1964.

Department of Civil Engineering

Course Name: **Railways, Airports, and Waterways**
Course Code: **CE-363**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the planning and design of railways and airports
- To introduce the fundamental concepts relevant to railway and airport engineering
- To enable the students to understand the factors affecting the design of airports and railways

Unit Number	Course Content	Contact Hours
UNIT-01	Components of Railway System: Elements of permanent way: Rails, Sleepers, Ballast, rail fixtures and fastenings, Track Stress, coning of wheels, creep in rails, signaling and interlocking	**08L**
UNIT-02	Railway Planning and Design: Geometric design of railways, gradient, super elevation, Points and Crossings, Railway stations and yards	**08L**
UNIT-03	Airport Planning: Airport classification, Airport components, criteria for airport site selection, Typical airport layouts, Airport Zones,	**07L**
UNIT-04	Airport Design: Runway Design and orientation, Wind Rose Diagram, Taxiway design, Runway Pavement Design Principles, Airport Markings and lighting, ATC	**07L**
UNIT-05	Ports and Harbors: Layout of ports, docks, and harbors, coastal protection structures, signals, Inland water transport	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify factors affecting airports and railways design
CO2: Describe the process of planning railways and airports
CO3: Apply principles of railways and airport planning

Books and References

1. A Course in Railway Engineering by Saxena Subhash C and Satyapal Arora, Dhanpat Rai and Sons
2. Airport Planning and Design by Khanna S K, Arora M G and Jain S S, Nemchand and Brothers, Roorkee
3. Transportation Engineering Vol.-II by C Venkatramaiah
4. Port and Harbor Engineering byR P Rethaliya, Atul Prakashan

Department of Civil Engineering

Course Name: **River Mechanics and Sediment transport**
Course Code: **CE-364**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

1. To impart knowledge about the mechanics of river flow and transport of sediments.
2. To introduce the fundamental concepts relevant to river mechanics, regime channels, sediment transport and sediment load.
3. To enable the students to understand the processes that govern sediment transport and behavior of river flow.

Unit Number	Course Content	Contact Hours
UNIT-01	Introduction to river mechanics, Width-to-depth ratio of a river, Two-phase motion and its dimensionless variables, Mechanical properties of flow, Aggrading rivers, Degrading rivers, Meandering rivers.	**09L**
UNIT-02	Introduction to sediment transport, Threshold of particle transport - critical velocity and critical shear stress concepts, Sediment movement in water, Bed Forms; Regime Channels, Channel roughness and resistance to flow, Tractive force method of stable channel design.	**09L**
UNIT-03	Principles of transport of solids in pipes, Principles of movement of sediment by waves tides and currents; Erosion, deposition, scour; Local scour problems.	**09L**
UNIT-04	Sediment Load, Bed load estimation - du Boys, Shields, Meyer Peter, Einstein bed load function, Yalin's formula, Paintals's stochastic approach, Suspended load - diffusion theory, Total sediment load by Kalinake, Latest models in sediment load assessment.	**09L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify different problems pertaining to river mechanics and sediment transport.

CO2: Describe problems related to meandering of rivers, formation of riverbed, resistance to flow, transport of sediments, load estimation on riverbed and other related mechanisms.

CO3: Apply governing principles and formulas to solve problems described in CO2.

CO4: Assess the results obtained by solving above problems

Books and References:

1. Braided Rivers: Process, Deposits, Ecology and Management by Gregory H., Blackwell Publishing.
2. Sediment Transport-Theory and Practice by Yang, C. T., McGraw Hill Companies, Inc., New Delhi.
3. Rivers Form and Process in Alluvial Channels by Richards, K., Methuen, NY.
4. River Mechanics, Vol. I and II by Shen, H.W., Water Resources Publication, Fort Collins, CO. Water Resource Publications.

Department of Civil Engineering

Course Name: **Probability and Statistics in Transportation Engineering**
Course Code: **CE-381**
Course Type: **Stream Core-I**

Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives

- To apply the concepts of probability, sampling distributions, test of hypothesis.
- To apply various probability distributions to calculate their statistical moments.

Unit Number	Course Contents	Contact Hours
UNIT-01	**Introduction:** Role of probability in Civil Engineering; Random events, random variables; Functions of random variables; Moments and expectations.	**04L**
UNIT-02	**Common probabilistic models – N**ormal, Lognormal, Poisson, external; Estimation of parameters; Goodness of fit test**;** Regression and correlation analyses.	**07L**
UNIT-03	Introduction to model reliability, FORM; Elements of quality assurance and acceptance sampling.	**04L**
UNIT-04	**Applications in Transportation Engineering:** Traffic flow models, crash analysis	**03L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Apply the concepts of probability, sampling distributions, test of hypothesis.
CO2: Apply Probability theory to find the chances of happening of events.
CO3: Apply various probability distributions to calculate their statistical moments.
CO4: Solve the problems on testing of hypothesis on large samples and small samples and fitting of the curves.

Books and References:

1. H.S. Ang and W.H. Tang, Probability Concepts in Engineering Planning and Design, Wiley, New York, 1975.
2. J.R. Benjamin and C.A. Cornell, Probability Statistics and Decision for Civil Engineers, McGraw Hill, New York, 1975.
3. R. Ranganathan, Reliability Analysis and Design of Structures, Tata McGraw Hill, New Delhi, 1990.
4. S.P.Gupta, Statistical Methods, 33rd Edition, Sultan Chand & Sons. 2. M.K.Jain, S.R.K.Iyengar and R.K.Jain.

Department of Civil Engineering

Course Name: **Water Resources System Modeling**
Course Code: **CE-382**
Course Type: **Stream Core**

Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives:

- To provide the knowledge on application of MATLAB to solve problems related to water resources systems by writing their own programs (codes)
- To introduce the statistical analysis on big datasets.
- To enable the students to employ basic models/tools in the field of water resources available in public domain.
- To impart knowledge to implement the soft-computing techniques in the field of water resources engineering

Unit Number	Course Content	Contact Hours
UNIT-01	Introduction to Programming (in MATLAB): Basic mathematical operations, loops, conditional statements, functions (inbuilt, user defined), arrays, file handling (input and/or output to various formats).	**05L**
UNIT-02	Applications through MATLAB: Basic statistical analysis, Interpolation (in 1D, 2D, 3D spaces), Contours, and Development of Regression based models and analysis, Principal Component Analysis.	**05L**
UNIT-03	Applications to Hydraulics, Hydrology and Water Resources: Water surface profiles (varied flow), Trend analysis, Time series modeling, Hydro-meteorological data download and analysis, design of canals.	**07L**
UNIT-04	Introductions to modelling applications related to Hydrology and Water Resources Engineering, Hands on training with models related to: Surface water flow, groundwater flow (MIKE Software).	**08L**
UNIT-05	Case-studies, data preparation, processing, and result reporting for field problems.	**05L**
UNIT-06	Introduction to Soft-computing techniques and their applications in water resources engineering.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Ability to formulate and solve problems related to water resources systems by writing their own programs (codes)
CO2: Ability to perform statistical analysis on big datasets.
CO3: Ability to employ basic models/tools in the field of water resources available in public domain.
CO4: Ability to implement the soft-computing techniques in the field of water resources engineering

Books and References:

1. Araghinejad, Shahab (2014) "Data-Driven Modeling: Using MATLAB® in Water Resources and Environmental Engineering", Water Science and Technology Library, Springer
2. Pratap, Rudra (2005) "Getting Started with MATLAB 7: A Quick Introduction for Scientists and Engineers" Oxford University Press.
3. Tayfur, G. (2012) "Soft Computing in Water Resources Engineering: Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms", WIT Press.

Department of Civil Engineering

Course Name: **Matrix Methods of Structural Analysis**
Course Code: **CE-383**
Course Type: **Stream Core**

Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives:

- To impart knowledge about the analysis of the statically and kinematically indeterminate structures
- To enable the students to understand the factors that cause such behavior of the indeterminate structure by matrix method.
- Analyze trusses, beams and frames using matrix flexibility method and matrix stiffness method

Unit Number	Course Content	Contact Hours
UNIT-01	**Flexibility Method:** Definition of flexibility influence coefficients - development of flexibility matrices by physical approach- flexibility matrices for truss, beam and frame elements - load transformation matrix - development of total flexibility matrix of the structure - analysis of simple structures - plane truss, beams and plane frame - nodal loads and element loads - lack of fit and temperature effects	**12L**
UNIT-02	**Stiffness Method:** Definition of stiffness influence coefficients -development of stiffness matrices by physical approach - stiffness matrices for truss, beams and frame elements - displacement transformation matrix - development of total stiffness matrix - analysis of simple structures - plane truss, beams and plane frame - lack of fit and temperature effects	**12L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Analyse trusses, beams and frames using matrix flexibility method and matrix stiffness method.
CO2: Carry out a dynamic analysis of structural systems.
CO3: Equip the students with the comprehensive methods of structural analysis and to attain ability to pursue higher studies in Civil Engineering

Books and References:

1. Moshe, F., Rubenstein, Matrix Computer Analysis of Structures, Prentice Hall, New York, 1986.
2. Structural Analysis- A Matrix Approach by G.S. Pandit and S.P. Gupta
3. Structural Analysis by L.S.Negi&R.S.Jangid, TATA McGraw Hill education.
4. matrix analysis of structures by C.Natarajan,PHI\
5. Weaver, W., and Gere, J.M., Matrix Analysis of Framed Structures, CBS Publishers, 2004.
6. Wilbur, J. B., Norris, C. H., and Utku, S., Elementary Structural Analysis, McGraw-Hill, 2006.
7. Rajasekaran, S., and Sankarasubramanian, G., Computational Structural Mechanics, PHI, 2001.
8. Manickaselvam V.K., Elements of Matrix and Stability Analysis of Structures, Khanna Publishers, New Delhi, 1998.
9. Reddy, C. S., Basic Structural Analysis, Tata McGraw-Hill, New Delhi, 2007. Menon, D., Advanced Structural Analysis, Narosa publishers, India,2008. Hibbler, R. C., Structural Analysis, Pearson Education, India, 2006.

Department of Civil Engineering

Course Name: **Management Industrial Waste**
Couse Code: **CE-384**
Course Type: **Stream Core**

Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives:

- Present scenario of industrial waste management in India nationally, in Maharashtra and in other states.
- Industrial waste generation patterns, as well as management and disposal techniques.
- Central and state pollution control board guidelines on industrial waste management.

Unit Number	Course Content	Contact Hours
UNIT-01	Industrial waste source, Nature and characteristics, quantity and quality of industrial wastes and their impact on the environment, waste volume reduction, waste strength reduction, neutralization, removal of suspended and colloidal solids, removal of inorganic and organic dissolved solids, disposal of sludge solid – treatment of cyanide waste – heavy metal and radio activity.	**12L**
UNIT-02	Management of industrial waste for various industries like dairy, sugar, paper, distillery, textile, tannery, food processing, fertilizer, pharmaceutical industry. Development of integrated treatment for wastewater – physico chemical treatment tertiary treatment methodologies - recent trends in clean technologies – zero polluting industry concept – Reuse and recycle of wastewater.	**12L**

Course Outcomes:

After the successful completion of the course student will be able to understand:
CO1: Schemes, incentives, policies on industrial waste management.
CO2: Overview of product design for waste minimization.
CO3: Cost benefit analysis of different waste management techniques

Books and References:

1. Liquid waste of Industries by Nemerow, N.L., Addison Wesely.
2. Wastewater Treatment by Rao M N and Datta A K, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
3. Industrial Water Pollution Control by Eckenfelder, McGraw-Hill.
4. Wastewater Engineering-treatment, Disposal, Refuse by Metcalf and Eddy, T.M.H. Edition, New Delhi.

Department of Civil Engineering

Course Name: **Advanced Steel Structural Design**
Course Code: **CE-431**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To understand the design concept of various steel structures
- To calculate the wind forces on various types of structures.
- To learn the analysis and design procedure of steel bunkers and silos
- To learn the analysis and design procedure of various types of steel water tanks and their staging.

Unit Number	Course Content	Contact Hours
UNIT-01	**Steel storage structures:** Design of steel tanks – types of tanks – elevated circular/rectangular tanks – stresses in spherical / conical bottom – circular girder – staging for circular/rectangular tanks/ pressed steel tanks. **Design of steel bunkers and silos** – Janssen's theory – Airy's theory – design parameters – design criteria – analysis of Bins – Hopper bottoms –design of bins	**10L**
UNIT-02	**Steel tall structures:** Chimneys: Design of self-supporting chimney – design principles of guyed chimney. **Transmission Towers:** Introduction–loads on towers– analysis–design of members and foundation.	**10L**
UNIT-03	**Steel Light gauge members:** Light gauge sections – design considerations – allowable stresses – buckling, design of compression members, tension members and laterally supported beams – connections.	**10L**

Course Outcomes:

On completion of the course, the students will be able to:
CO 1: Design Industrial structures and their components such as girts, wind girders, bracings systems purlins etc
CO 2: Design steel bunkers and silos
CO 3: Design steel water tanks and their staging

Books and References:

1. Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi 2008.
2. Bhavikatti, S.S., Design of Steel Structures, I.K. International Publishing House Pvt. Ltd., New Delhi, 2010.
3. IS 800 - 2007, Code of practice for general construction in steel, Bureau of Indian Standards, New Delhi.
4. IS875 Part (3) - 1987, Code of Practice for Design Loads (other than earthquake) for buildings and structures: Wind loads. Bureauof Indian Standards, New Delhi.

Department of Civil Engineering

Course Name: **Design of Hydraulic Structures**
Course Code: **CE-432**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about design and application of various hydraulic structures.
- To introduce the fundamental concepts relevant to reservoir operations, cross drainage works, dams, spillways, and energy dissipaters.
- To enable the students to understand the theoretical and practical application of these hydraulic structures.

Unit Number	Course Content	Contact Hours
UNIT-01	Reservoir Planning: Investigations, Layout, selection of site for hydraulic structures, life of Reservoir.	**02L**
UNIT-02	Structures on Permeable foundations: Bligh's creep theory, limitations, Khoslas's theory of independent variable, Khosla's corrections, Canal Head Works, Design of Weir and Barrages.	**10L**
UNIT-03	Canal Structures: Design of canal falls, Regulators, Cross drainage works: Selection, design aspects of aqueducts, siphon aqueducts, supper passages, canal siphon and level crossings.	**03L**
UNIT-04	Earth Dams: Types, causes of failure, soils suitability for earth dam construction, typical earth dam sections, estimation of seepage through and below the dam, seepage control, stability of slopes.	**10L**
UNIT-05	Gravity dams: Design Criteria, forces acting on gravity dams, elementary profile, Forces on gravity dams, stability analysis.	**03L**
UNIT-06	Spillways and Energy dissipaters: Purpose, different types, details of ogee, syphon, shaft, chute and side channel spillways, design aspects, Principles of energy dissipation, Energy dissipaters based on tail water rating curve and jump height curves.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify different problems pertaining to design and application of hydraulic structures.
CO2: Describe problems related to planning, site selection and design of reservoirs, canals, regulators, wiers, earth dams, gravity dams, spillways and energy dissipaters.
CO3: Apply principles and design criterion to solve problems mentioned in CO2.
CO4: Assess the results obtained by solving above problems.

Books and References:

1. Engineering for Dams (Volumes I, II & III) by Creager, Justin & Hinds.
2. Hydroelectric Handbook by Creager.
3. Hydraulic Structures by Varshney.
4. Irrigation & Waterpower Engg. By Punmia & Pandey B.B.Lal.
5. Water Power Engineering by Dandekar.

Department of Civil Engineering

Course Name: **Forensic Geotechnical Engineering**
Course Code: **CE-433**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To understand the reasons of soil-interaction related failures of engineered facilities or structures.
- To impart the knowledge about failures connected with geotechnical and geological origin to improve professional practice, codes of analysis and design as well as practice.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction**: Historical failures of geotechnical structures (finite and infinite slopes, high embankments such as earthen dams, tunnels, excavations, foundations-shallow and deep, retaining structures etc.), characterization of failures, inadequateness of limit state design, principles and advantages of mobilizable strength design.	**10L**
UNIT-02	**Technical Forensic Investigation**: Collection of data, problem characterization, development of failure hypotheses, a realistic back analysis, field observations and performance monitoring, modeling of failure hypothesis and quality control of formal and technical aspects of the work.	**04L**
UNIT-03	**Case Histories**: Case histories of construction of historic monuments, destruction due to environmental changes and survival of monuments such as leaning tower of pisa, egyptian pyramids, tall structural foundations, guidelines for geotechnical forensic investigation, types of distress.	**05L**
UNIT-04	**Diagnostic Tests**: Field and laboratory tests, analysis, legal issues such as facts, interpretations, opinions, negligence technical issues related to geotechnical failures: primary shortcomings causing failures, shortcomings in design, inadequate site investigations, unforeseen occurrences and phenomena, shortcomings in construction; recommendations to limit future occurrence of failures.	**04L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

1. Deal with investigations of soil-interaction related failures of engineered facilities or structures.
2. Analyze failures connected with geotechnical and geological origin to improve professional practice, codes of analysis and design as well as practice.

Books and References:

1. Robert W. Day, Forensic Geotechnical and Foundation Engineering, Mc Graw Hill.
2. Rao V.V.S and Sivakumar Babu G.L, Forensic Geotechnical Engineering, Springer New Delhi

Department of Civil Engineering

Course Name: **Optimization Methods**
Course Code: **CE-434**
Course Type: **Discipline Elective**
Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the optimization
- To impart knowledge about the multi-objective nature of Engineering Design
- To Apply optimization methods to solve the Engineering Design Problems

Unit Number	Course Content	Contact Hours
UNIT-01	Basics of engineering analysis and design, need for optimal design, formulation of optimization problem, classical-simplex search, gradient search.	**10L**
UNIT-02	Newton Raphson and global Optimization Techniques-Introduction to GA, Constrained and Unconstrained optimization problems, Convex optimization, Sensitivity analysis, Numerical methods for nonlinear optimization problems.	**10L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Understanding the basic concepts of classical optimization.
CO2: Analysis of optimization algorithms
CO3: Applications of optimization in Civil Engineering

Books and References:

1. Optimization for engineering design: Algorithms and examples by K. Deb, PHI Pvt Ltd.
2. Introduction to optimum design by J.S. Arora, McGraw Hill International editions.
3. Elements of structural optimization by R.T. Hafta and Z. Gurdal, Kluwer academic publishers.
4. Engineering Optimization theory and Practice by S. S. Rao, New Age International.

Department of Civil Engineering

Course Name: **Elementary Structural Dynamics**
Course Code: **CE-451**
Course Type: **Stream Core**

Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives:

- To introduce the concepts of dynamic systems
- To study the dynamic response of SDOF
- To study the dynamic response of MDOF
- To introduce the continuous systems subjected to different types of dynamic loads.
- To learn free and forced vibrations response of structural systems

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction to Dynamics of Structural Systems:** Dynamic analysis - Elements of vibratory systems and Simple Harmonic Motion. continuous systems and discretization; significance of single degree of freedom system in dynamic analysis of structural systems. Introduction to Analytical Dynamics: Work and energy; principle of virtual work; D'Alembert's principle; Lagrange equations of motion.	**05L**
UNIT-02	**Free Response of Singe-Degree-of-Freedom Linear Systems:** General considerations; characteristics of discrete system components; differential equation of motion of second-order linear systems; free vibration response of undamped and damped single degree of freedom systems; logarithmic decrement; critical, under and over-damped systems. Viscous damping and Coulomb damping. Evaluation of damping	**05L**
UNIT-03	**Forced Response of Singe-Degree-of-Freedom Systems:** Response of second-order systems to harmonic excitation; harmonic motion of support; complex vector representation of harmonic motion; Forced vibration of undamped and damped systems –Structures subjected to harmonic loads -vibration isolation; vibration measuring instruments; energy dissipation and structural damping; superposition and response to periodic excitation; Fourier series; the unit impulse and impulse response; unit step function and step response; response to arbitrary excitation; the convolution integral; general system response.-Resonance condition. Dynamic Amplification Factors. General types of loads - Duhamel's integral approach to solution.	**05L**
UNIT-04	**Multi-Degree-of-Freedom Systems: Equations of motion;** generalized coordinates; matrix formulation; stiffness and mass matrices; linear transformations and coupling; undamped free vibration; eigenvalue problem; natural frequencies and mode shapes; orthogonality of modal vectors; expansion theorem; response to initial excitation; modal analysis; solution of eigen value problem by matrix iteration; power method; Rayleigh's coefficient; Iteration due to Holzer and Stodola ,general response of discrete linear systems; modal analysis. Idealization of multi-storeyed - lumped SDOF system	**05L**

Course Outcomes:

On completion of the course, the students will be able to:
CO1: Mathematically model a structural system for dynamic analysis.
CO2: Carry out free vibration analysis of single degree of freedom.
CO3: Analyze a single degree of freedom systems to subjected to harmonic loading, periodic loading and general dynamic loadings
CO4: Perform free vibration and forced vibration analyses of multi degree of freedom systems.
CO5: Learn to analyze a continuous system both as a distributed parameter system and as an approximate discrete parameter system with multiple degrees of freedom.
CO6: Analyze continuous systems subjected to different types of dynamic loads.

Books and References:

1. Clough,R.W. and Penzien, J., Dynamics of structures, McGraw Hill, 1993.
2. Chopra, A.K., Dynamics of structures - Theory and Application to Earthquake Engineering, Prentice Hall of India, 1996.
3. IS 1893 - Criteria for Earthquake Resistant Design of Structures, 2002.
4. SP 22: Explanatory Handbook on Codes for Earthquake Engineering.
5. Meirovitch L., Elements of Vibration Analysis, Mc.Graw Hill, 1986.
6. Thomson W.T., Theory of Vibration with Applications, Pearson Education Inc., 1998.
7. Craig, Jr. R.R., Structural Dynamics, John Wiley, 1981.
8. Hurty, W.C. and Rubinstein M.F., Dynamics of Structures, Prentice Hall, 1964.
9. Mario Paz, Structural Dynamics, CBS, Publishers, 1987.

Department of Civil Engineering

Course Name: **Probabilistic Methods and Stochastic Hydrology**
Course Code: **CE-452**
Course Type: **Stream Core**

Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives:

CO1: To understand the hydrological cycle and hydrologic statics.
CO2: To assess the hydrologic simulation models.
CO3: To evaluate the statistical principles and techniques for hydrologic time series modeling.
CO4: To analyze the parameter estimation methods

Unit Number	Course Content	Contact Hours
UNIT-01	The Hydrological Cycle: Global Water and Energy Budgets, Philosophy of Mathematical Models of Watershed Hydrology. Hydrologic Statistics: statistical parameter estimation, probability distribution, goodness of fit, concepts of probability weighted moments & L–moments, frequency analysis, Markov process, Markov chain, and reliability analysis.	**03L**
UNIT-02	Hydrologic Simulation Models; major hydrologic models, single and multiple regression analysis.	**03L**
UNIT-03	Classification of time series, characteristics of hydrologic time series, statistical principles and techniques for hydrologic time series modeling, time-series modeling of annual and periodic hydrologic time series (including AR, MA, ARMA, ARIMA models), multivariate modeling of hydrologic time series, practical considerations in time series modeling applications.	**11L**
UNIT-04	Key Statistical Measures of Data, Graphical Presentation of Data, Probability Distributions, Parameter Estimation Methods, Problems of Parameter Estimation, Hypothesis Testing.	**03L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Evaluation of hydrological cycle and hydrologic statics.
CO2: Assessment hydrologic simulation models
CO3: Evaluation of statistical principles and techniques for hydrologic time series modeling
CO4: Analysis of parameter estimation methods.

Books and References:

1. Bras, R. L., and Rodriguez-Iturbe, 1994, "Random Functions and Hydrology", Dover Publications, New York.
2. Chow, V. T., D. R. Maidment, and L. W. Mays; "Applied Hydrology", McGraw Hill International Editions.
3. Haan, C. T., 2002, "Statistical Methods in Hydrology", 2nd ed., Blackwell Publishing, Ames, IA.
4. Haan C.T. “Stochastic Hydrology”
5. Hoskings, J. R. M. and J. R. Wallis, 1997, "Regional Frequency Analysis, An Approach Based on L-Moments", Cambridge University Press, New York.
6. Maidment, D.R., “Handbook of Hydrology”, Mc Graw Hill Inc
7. Reddy, P. Jaya Rami. “Stochastic Hydrology” Laxmi Publications Pvt Limited
8. Viessman Jr., W., and G. L. Lewis, "Introduction to Hydrology", 4th ed., Harper-Collins, New York, 1996.

Department of Civil Engineering

Course Name: **Ground Improvement Techniques**
Course Code: **CE-453**
Course Type: **Stream Core**

Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives:

To impart knowledge about the various ground improvement techniques.

To enable the students to understand the factors that control the choice of ground improvement technique as per the field condition.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction**: Need and objectives of Ground Improvement, Classification of Ground, Modification Techniques - suitability and feasibility, Emerging Trends in ground improvement, methods of de-watering.	**05L**
UNIT-02	**Compaction**: Principles of compaction, Engineering behaviour of compacted clay, field compaction techniques, static vibratory, impact, Earth moving machinery, Compaction control, application to granular soils, cohesive soils, depth of improvement, environmental considerations, induced settlements, vibro compaction and replacement process, preloading techniques, surface compaction.	**06L**
UNIT-03	**Grouting**: Chemical grouting, commonly used chemicals, grouting systems, grouting operations, applications, compaction grouting, application and limitations, plant for preparing grouting materials, jet grouting, jet grouting process, geometry and properties of treated soils and applications.	**03L**
UNIT-04	**Stabilisation**: Introduction to soil improvement by adding materials, lime, flyash, cement and other chemicals and bitumen, sand column, stone column, sand drains, prefabricated drains, lime column, soil-lime column, stabilization of soft clay or silt with lime, bearing capacity of lime treated soils, settlement of lime treated soils, improvement in slope stability, control methods.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Understand the basic mechanics of the various ground improvement techniques

CO2: Apply the appropriate ground improvement technique to the field situation

Books and References:

1. Text Book on Ground Improvement by Blackie Moseley
2. Text Book on Grouting in engineering Practice by R. Boweven
3. Text Book on Soil Reinforcement with Geotextiles by R. A. Jewell
4. Text Bok on Soil Improvement Technique and their Evolution by W.E. Van Impe

Department of Civil Engineering

Course Name: **Construction Management**
Course Code: **CE-454**
Course Type: **Stream Core**

Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives:

- To impart knowledge about types, merit, and demerits of construction contracts,
- To introduce the fundamental concepts relevant to CPM and PERT, and
- To enable students to understand organizational structures in the construction industry

Unit Number	Course Content	Contact Hours
UNIT-01	Construction Management Significance, objectives and functions, resources for construction industry, stages in construction, Civil Engineering drawings.	**03L**
UNIT-02	Construction Contracts & Specifications Types of contracts, contract document, specifications, important conditions of contract, arbitration.	**05L**
UNIT-03	Construction Organization Principles of organization, communication in organization, types of organizations, temporary services, job layout.	**04L**
UNIT-04	Construction Planning Work breakdown structure, pre-tender stage planning, contract stage planning, scheduling, bar charts, limitations of bar charts, milestone charts, preparation of material, equipment, labor, and finance schedule	**06L**
UNIT-05	Critical Path Method Network techniques, element of a network, rules for developing networks, development logics, numbering events, time computations, activity floats, network updating. Resources profile, resources smoothing and resources leveling.	**03L**
UNIT-06	Cost-Time Analysis Cost versus time, direct cost, indirect cost, total project cost, optimum duration, contracting network for cost optimization.	**05L**
UNIT-07	Program Evaluation and Review Technique Probability concept in network, optimistic time, pessimistic time, most likely time, variance, standard deviation, slack, central limit theorem. probability of achieving completion time.	**04L**
UNIT-08	Construction equipment: selection, bulldozer, dumpers, trenchers, excavators, hoe, hoists, graders, piling hammers, pumps, compressors, bitumen mix plant, rollers, clam shell, aggregate production techniques, crushers.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Understand purpose, types, merit, and demerits of construction contracts, CO2: Develop organizational structures in the construction industry,

CO3: Develop critical path method-based network and estimate various times and floats, and

CO4: Develop PERT network and find probability of completion of a project in specified duration.

Books and References:

1. Project Management: Planning and Scheduling Techniques by Bansal, V. K., Routledge: Taylor& Francis Group.
2. Construction Planning & Management by P.S. Gehlot & B.M. Dhir
3. PERT & CPM -Principles & Applications by L.S. Srinath.
4. Project Planning & Control with PERT & CPM by B.C. Punmia & K.K. Khandelwal,
5. Construction Management & Planning by B. Sengupta & H. Guha,
6. Construction Planning equipments and methods: R.L. Peurify .

Department of Civil Engineering

Course Name: **Prestressed Concrete**
Course Code: **CE-471**
Course Type: **Stream Core**

Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives:

- To impart knowledge about the Principle of Prestressing, Prestressing materials, and systems of Prestressing
- To enable the students to understand various losses in Prestressing.
- To enable the students to understand the design concept of prestressed beam, tension, and compression members.
- To comprehend the principles of Circular prestressing

Unit Number	Course Content	Contact Hours
UNIT-01	**Basic principles**: Introduction – need for prestressed concrete – structural behaviour of prestressed concrete member – methods of prestressing – pre-tensioning and post-tensioning – anchorage systems – types of prestressed concrete – comparison with reinforced concrete. **Materials:** Materials to be used, steel and its properties, concrete and its requirements, High tensile steel – types of prestressing steel -high strength concrete – properties of high tensile steel and high strength concrete. **Losses in prestress:** Immediate losses – time dependent losses – total losses. Losses due to length effect, curvature effect, loss of stress at anchoring stage, due to shrinkage and creep of concrete, elastic shortening of concrete, relaxation of steel- temperature effects.	**06L**
UNIT-02	**General principles of prestressing:** Assumption, general principles, eccentric tendons, bent tendons and parabolic tendons. Analysis of prestressed beams, load balancing concept. **Prestressing systems:** Classification of prestressed concrete members, externally and internally prestressed members, pretensioning and post tensioning. **Analysis of sections:** Analysis at serviceability limit state – combined load approach – internal couple approach – equivalent load approach – concept of load balancing – decompression moment – cracking moment	**07L**
UNIT-03	**Design for flexure**: Modes of failure in flexure – ultimate moment of resistance of sections with bonded tendons – strain compatibility method – IS code procedure. **Design of flexural members:** Governing stress inequalities for un-cracked sections – design of prestressing force – Magnel's diagram – allowable cable zone – flexural efficiency factor. **Design for shear and torsion:** Effect of prestress in shear strength – zones for shear design – shear resistance of sections – design for shear – Shear stresses, principal tensile stresses, shear reinforcement, effect of vertical prestressing. Failure modes in torsion – design for torsion. **Design of anchorage zones:** Anchorage zones in pre-tensioned members – development length – end zone reinforcement – anchorage zones in post-tensioned members – bearing stresses – bursting forces – end zone reinforcement. **Control of deflections:** Deflection in type I and type II beams– short term and long-term deflections – IS code procedures. **Design of prestressed beams:** Principle of design, I.S. Code provisions, design of rectangular and I-section and continuous beams.	**10L**
UNIT-04	**Tension and compression members**: Design of tension members and compression members. End-block: Stress- analysis, transmission zones, bursting and spalling stresses, anchor plates placed symmetrically and eccentrically. Design problems. **Circular prestressing:** Introduction and General principles	**07L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Design prestressed beam, compression and tesion members using relevant codes for industrial practice.
CO2: Analyse prestressed concrete structural members and estimate the losses of prestress.
CO3: Identify various materials required for prestressing and systems of prestressing.
CO4: Analyse and design of prestressed concrete structural elements as per IS 1343
CO5: Design prestressed concrete flexural members, composite members and statically indeterminate structures

Books and References:

1. Design of Prestressed Concrete by T.Y. Lin, Wiley
2. Prestressed concrete by Krishna Raju,N., Tata McGraw Hill.
3. Prestressed concrete by N. Rajagopalan, Narosa Publishing House
4. Standard Specifications and code of Practice for PSC.
5. Nagarajan, P.,Prestressed concrete Design, Pearson,2013.
6. Dayaratnam, P., Prestressed Concrete, Oxford and IBH, 1982.

Department of Civil Engineering

Course Name: **Geo-synthetics**
Course Code: **CE-472**
Course Type: **Stream Core**

Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives:

- To impart knowledge about the geosynthetic materials.
- To introduce the fundamental concepts relevant to application of geosynthetics to the civil engineering problems.
- To enable the students to understand the applicability of geosynthetics.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction**: Geosynthetics, Types, Advantage and Disadvantage, Basic characteristics, Raw materials.	**04L**
UNIT-02	**Geosynthetic manufacturing**: Manufacturing processes, Functions.	**04L**
UNIT-03	**Properties of geosynthetics**: Physical properties, Mechanical properties, Hydraulic properties, Endurance and degradation properties, Tests, and allowable properties, concept of quality and its evaluation, selection.	**06L**
UNIT-04	**Applications**: Introduction, Retaining walls, Embankments, Shallow foundations, Roads, Unpaved roads, Paved roads, Railway tracks, Filters and drains, Slopes, Erosion control, Stabilization, Ponds, Reservoirs, Canals, Earth dams, Tunnels, Installation survivability requirements.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify the various geosynthetic materials
CO2: Learn about their manufacturing processes
CO3: Apply concepts to the designing with geosynthetics of various civil engineering structures

Books and References:

1. Geosynthetics and Their Applications by S. K. Shukla and J.H Yin
2. Geotextiles and Geomembranes in Civil Engg- Gerard P.T.M. Van Santvrot, A.A. Balkema, Oxford and IBH publishing company, New Delhi.
3. Reinforced Soil and Geotextiles -J.N. Mandal, proceedings FIGC- 1988, Oxford and IBH publishing company private Ltd., New Delhi.
4. Geosynthetics: Application, Design and Construction- R.J. Tarmat, proceedings First Europian Geosynthetics Conference, Netherland. A. A. Balkema, Publisher-Brookfield, U.S.A.
5. Geosynthetics World -J.N. Mandal, Willey Eastern Limited, New Delhi

Department of Civil Engineering

Course Name: **Open Channel Hydraulics**
Course Code: **CE-473**
Course Type: **Stream Core**
Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives:

- To develop a basic knowledge of open channel flow relationships by applying fluid properties.
- To gain proficiency in applying the basic principles of flow for ideal and real fluids in open channel flow problems.

Unit Number	Course Content	Contact Hours
UNIT-01	Fluid properties, Forces on submerged objects, Similitude and dimensional analysis, the energy equation for an ideal fluid. Introduction to flow in open channels- Velocity profiles, the energy equation applied to real fluids, Flow resistance, Computations for steady, uniform flow. Flow in channel sections with variable roughness, the momentum principle, Specific energy.	**10L**
UNIT-02	Gradually varied flow in open channels, Determination of flow resistance in open channels, Classification of water-surface profiles, Local energy losses in natural channels, Water-surface profile computations. Discharge computations for rapidly varied flow, rapidly varied flow at constrictions, Flow through culverts, Flow over weirs.	**10L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Summarize the differences between flow types and controlling features in open channel flows
CO2: Explain the terms of the open channel flow equations and explain the interactions among the terms.
CO3: Solve open channel flow problems through the selection and use of appropriate equations.
CO4: Able to design culverts.

Books and References:

1. Basic Hydraulic Principles of Open-Channel Flow by Harvey E. Jobson and David C. Froehlich. U.S. Geological Survey, Books.
2. Open Channel Hydraulics by Chow, V.T, McGraw Hill, New York.
3. Open Channel Flow by Hendersen, F.M., McGraw Hill, New York.
4. Irrigation Engineering and Hydraulic Structures by S.K. Garg, Khanna Publishers.
5. Flow in Open Channels by K. Subramanya, Tata McGraw Hill.
6. Fluid Mechanics by V.L. Streeter and E.B. Wylie, McGraw Hill.
7. Fluid Mechanics by B.F. White, McGraw Hill, 1994.
8. Irrigation and Water Power Engineering by B.C. Punmia, Standard Publishers.
9. Fluid Mechanics with Engineering Applications by J. Frabzini, McGraw Hill.

Department of Civil Engineering

Course Name: R**oad Safety Engineering**
Course Code: **CE-474**
Course Type: **Stream Core**

Contact Hours/Week: **2L** Course Credits: **02**

Course Objectives:

- To understand the fundamental principles of road safety engineering and auditing
- To understand the Safe systems approach adopted in global road safety.

Unit Number	Course Content	Contact Hours
UNIT-01	Introduction to Road safety engineering: Foundations of road safety, Scope of study, introduction to Global road safety.	**03L**
UNIT-02	Road User Characteristics and safety: Describe Road user visual and cognitive capabilities and limitations, Describe driver visual search, Describe importance of driver expectancy, Identify variables affecting perception-reaction time, Drivers adaptations to traffic control devices	**05L**
UNIT-03	Systematic approach to road safety: Factors causing road crashes, Safety issues in road transport- pedestrians, bicyclists and private and public motorized vehicles, Speed management,	**03L**
UNIT-04	Safe systems approach: Foirgiving roadsides and cross sections, Intersection safety, Effective signs and street lighting, Designing for all road users, Safety in construction zones	**03L**
UNIT-05	Road safety management: Accident analysis and interventions, Effective black spot programmes, Introduction to road safety audit and inspection, Economics of road safety, Climate resilience and road safety engineering, Stakeholders in road safety engagement, Its and other interventions	**04L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Apply Safe systems safety approach using transportation engineering.
CO2: Different measures essential for well-functioning road infrastructure safety management.

Books and References:

1. David Shinar, Psychology on the Road: The Human Factor in Traffic Safety.
2. American Association of State Highway Transportation Officials (AASHTO), Highway Safety Manual (HSM).
3. EU-Global Road safety initiatives.

Department of Civil Engineering

Course Name: **Hydro Power Engineering**
Course Code: **CE-461**
Course Type: **Stream Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the processes and machinery involved in hydro power generation.
- To introduce the fundamental concepts relevant to hydraulic machines, hydropower projects, installation and development, economic analysis and issues related to hydropower projects.
- To enable the students to understand development and application of hydropower generation.

Unit Number	Course Content	Contact Hours
UNIT-01	**Turbo Machinery:** Governing Equations, Hydrodynamic forces of jets on vanes. Turbines: Classification, impulse and reaction turbines, characteristic curves, draft tubes, governing of turbines, specific speed, unit quantities concept, cavitation. Pumps: classification, work done, minimum starting speed, losses and efficiencies, specific speed, multistage pumps, Cavitation in pumps.	**08L**
UNIT-02	**Hydro Power Development:** Sources of energy and their comparative study, investigations and studies for hydropower development, estimation of available waterpower, flow and power duration curves, firm power and secondary power, plant capacity, installed capacity, constraints in hydropower development, operation and maintenance of hydropower plants, small hydropower development. Classification of hydro-power plants based on storage characteristics, operating head, load, capacity. Principal components of hydro-electric scheme. Storage and pondage, economic analysis of storage capacity, aspects of cost allocation for different purposes, reservoir operation using flow duration and flow mass curves.	**10L**
UNIT-03	**Hydroelectric Plants:** Layout of hydropower plants, types of power houses, various components, investigations and studies, safety requirements. Storages zones of a reservoir, reservoir sedimentation, trap efficiency, life of a reservoir, principles of desilting, design of desilting basins. Alignment and location of various types of intakes, trash racks, design of intake structures. Conveyance channels and tunnels, water hammer, surge tanks, design of surge tanks, penstocks classification and layout, hydraulic design of penstocks, hydraulic valves and gates, tail race channels.	**08L**
UNIT-04	**Economics of Hydro power installation**: Engineering feasibility, political consideration, economic feasibility, analysis of cost of hydro power, preparation of pre-feasibility report, detailed project report, cost and estimate report.	**10L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify the type of machinery and hydroelectric plant required for power generation.
CO2: Describe the problems involving turbines, pumps, classification and site selection for hydropower plant, losses in hydropower generation, reservoir operation, design and economic feasibility of plants.
CO3: Apply governing principles and fundamental relations to solve problems mentioned in CO2
CO4: Assess the results obtained by solving above problems.

Books and References:

1. Fluid Mechanics and Hydraulic Machines by Modi, P.N., and Seth, S.M., Hydraulics, Standard Book Home, New Delhi, 2005.
2. Textbook of Fluid Mechanics and Hydraulic Machinery by Rajput, R.K., S. Chand & Company, Ltd., New Delhi, 2005.
3. Hydro-electrical Engineering by Creager and Justin
4. Waterpower Engineering by Barrows
5. Waterpower Development (Vol.-I and II) by Mosony L. Emil
6. Hydro –Electric and Pump storage Plants by MG Jog, Wiley Eastern Limited
7. Micro Hydroelectric Power Stations by L. Monition,
8. Hydro Power Plant Familiarization- NPTI Publication.
9. Waterpower engineering-The theory, investigation and development of water powers by Daniel W. Mead, Member ASCE, Mcgraw-Hill Book Co.

Department of Civil Engineering

Course Name: **Bridge Engineering**
Course Code: **CE-462**
Course Type: **Stream Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To develop an understanding of and appreciation for basic concepts in proportioning and design of bridges in terms of aesthetics, geographical location, and functionality.
- To help the student develop an intuitive feeling about the sizing of bridge elements, ie. develop a clear understanding of conceptual design.
- To understand the load flow mechanism and identify loads on bridges.
- To carry out a design of bridge starting from conceptual design, selecting suitable bridge, geometry to sizing of its elements
- To learn the components of bridges, classification of bridges, importance of bridges.
- To familiarize students with various types of concrete bridges such as slab-bridge, T-beam bridge.
- To get exposure the substructure of bridge substructures and the evaluation and importance of bearings

Unit Number	Course Content	Contact Hours
UNIT-01	**Elements of bridge engineering:** Definitions, components of a bridge, classification, importance and Site Selection, water way. Site selection, data drawing, design discharge linear water way, economical span, location of piers and abutments, vertical clearance above HFL scour depth. Traffic projection, investigation report choice of bridge type, selection of Bridge cross-section and longitudinal form, Characteristics of each type. Introduction to bridge codes, Design loads Specification for Road and Railway bridges; General design consideration. Width of carriageway –loads to be considered -dead load –IRC standard live load and IRS loading– Impact effect.	**07L**
UNIT-02	**Culverts:** Design of R.C.C slab culvert (Design of deck slab), Pipe culvert and Box culvert based on variety of IRC vehicle loading.	**10L**
UNIT-03	**RC Slab and Tee Girder Bridges:** Design of solid deck slab, Longitudinal beam and Cross beam based on variety of IRC vehicle loading (superstructure only) **Steel bridges:** truss bridge-plate girder bridge (superstructure only)	**12L**
UNIT-04	**Bridge Piers, Abutments, wing-wall and approaches, bridge foundation:** Types and stability analysis of piers and **Abutments,** Loads, abutments, and wing wall design. **Bridge Foundations:** Types of Bridge foundations, Pile and well foundations.	**12L**
UNIT-05	**Bridge Bearings and expansion joints:** Necessity of bearings, Types of bearings and expansion joints, Design of Elastomeric Bearings, Necessity and types of expansion joints	**07L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Develop an understanding of different types of bridge loadings, design of super& sub structure.
CO2: Describe the design features integrating the principles of design and become familiar with professional and contemporary issues in design and detailing of reinforcement.
CO3: Apply principles of analysis and design to the different types of bridges
CO4: Read and execute the drawings and detailing of reinforcement for the designed Bridges in the field.
CO5: To be familiar with the components of bridges, classification of bridges, importance of bridges.
CO6: To understand the specification of road bridges, loads to be considered.
CO7: To be familiar with various types of concrete bridges such as slab-bridge, T-beam bridge, pre-stressed concrete bridge.
CO8: To be familiar with various types of steel bridges such truss bridge and girder bridge.
CO9: To get exposed to evaluation of sub structures, type of foundations, importance of bearings

Books and References:

1. Essentials of Bridge Engineering, 6th Ed by Johnson Victor, D. (2008), Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. "Design of Bridges" by Krishna Raju, N. (2006), 3rd Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. "Bridge Superstructure" by N. Rajgopal (2006), Narosa Publishing House, New Delhi
4. "Concrete bridge Practice: Analysis by V. K. Raina(2002, Design and Economics", TMH.
5. "Design of concrete bridges" by Aswani, M.G., Vazirani, V.N. and Ratwani, M.M (1975), Khanna publishers.
6. "Bridge Engineering" by Ponnuswamy S. (1996), Tata McGraw-Hill, New Delhi.
7. "Design of Bridge structures" by T.R.Jagadish and M. A. Jairam, Prentice hall of India, New Delhi
8. "Bridge Engineering" by Phatak D.R. (1990), SatyaPrakashan, New Delhi.
9. "Bridge Analysis Simplified" by Bakht,B. and Jaegar, L.G.(1985 McGraw-Hill, New Delhi.
10. "Dynamics of Railway Bridges" by L. Fryba(1996), Thomas Telford.
11. Indian Standard Codes and IRC codes related to bridges.

Department of Civil Engineering

Course Name: **Structural Health Monitoring & Retrofitting of Structures**
Course Code: **CE-463**
Course Type: **Stream Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To understand the structural health monitoring for structures.
- To understand the conditional assessment & techniques for strengthening and retrofitting of structures.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction of Structural Health Monitoring:** Need of Structural Health Monitoring, Definition & Concept of SHM, SHM & Biomimetic Comparison of SHM with NDT, Types & Components of SHM, Procedure of SHM, Objectives & Operational Evaluations of SHM, Advantages of SHM.	**09L**
UNIT-02	**Methods of SHM Methodologies and Monitoring Principles:** Local & Global Techniques for SHM, Static & Dynamic Field Testing, Short & Long-Term Monitoring, Active & Passive Monitoring. Vibration Based SHM Techniques - Use & Demonstration of Dynamic Properties of Structures for Damage Detection & SHM, Ambient Vibration Test, Acoustic Emission Technique, Electromechanical Impedance Technique, Wave Propagation Based Techniques, Fibre Optics Based Techniques, Remote & Wireless SHM Techniques, IoT Application in SHM, Artificial Intelligence & Machine Learning in SHM.	**09L**
UNIT-03	**Structural Assessment:** Structural Assessment & Need for retrofitting: Introduction to health assessment of structures, structural damages & failures, Principles of structural assessment, Classification & levels of assessment, Current scenario of infrastructure through case studies.	**09L**
UNIT-04	**Retrofitting of Structures**: Concept of repair & retrofitting of structures: Case studies of structural & foundation failure, performance problems, responsibility & accountability, causes of distress in structural members, design and material deficiencies, factors causing extensive Deterioration. Retrofitting of structures: Fundamental of retrofitting, Flow of retrofitting process, Methods of retrofitting, Materials for retrofitting (conventional and smart materials), selection of retrofitting methods.	**09L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Understand how to assess the health of structures using different techniques of SHM.
CO2: Identify suitable techniques for structural condition assessment.
CO3: Decide the appropriate strengthening & retrofitting techniques to regain the structural strength.

Books and References:

1. Structural Health Monitoring, Daniel Balageas, Peter Fritzen, Alfredo Guemes, John Wiley & Sons,2006.
2. Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E.
3. Adams, John Wiley and Sons, 2007. Structural Health Monitoring and Intelligent Infrastructure, Vol1, J. P. Ou, H. Li and Z. D. Duan.
4. Taylor and Francis Group, London, UK, 2006.
5. Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, Academic Press Inc,2007.

Department of Civil Engineering

Course Name: **Environmental Impact Assessment**
Course Code: **CE-464**
Course Type: **Discipline Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To understand the concepts of ecology, sustainable development, and EIA.
- To explore current EIA process in India.
- To acquire knowledge about various methods for conducting EIA, Environmental Legislation & Environmental Audit

Unit Number	Course Content	Contact Hours
UNIT-I	**Environmental management**- problems and strategies - Review of political, ecological and remedial actions - future strategies - multidisciplinary environmental strategies decision making and concepts of sustainable development. Concept of environmental audit - Life Cycle Analysis (LCA) - Environmental Management System - Introduction to ISO 14000, OSHA and Clean Development Mechanism (CDM) & Carbon credits. Introduction to various major natural disasters - flood, tropical cyclone, droughts, landslides, heat waves, earthquakes, fire hazards, tsunami etc., Factors for disaster - climate change, global rise in sea level, coastal erosion, environmental degradation, large dams, Legislative responsibilities of disaster management.	**12L**
UNIT-II	Environmental legislation of Air, Water & Hazardous Waste - Environment Protection Act-1986 - Regulatory standards of CPCB / GPCB / BIS - EIA need and Notification - Environmental clearance.	**06L**
UNIT-III	Introduction and Planning: Evolution of Environmental Impact Assessment - concepts of EIA - EIA methodologies screening and scoping - rapid and comprehensive EIA - General framework of EIA - characterization and site assessment - Environmental inventory - Prediction and assessment of impact - Impact assessment methodologies like adhoc method, checklist, overlap, network, model, and index method. Decision methods of evaluation of alternatives - development of decision matrix - Public participation in environmental decision making - Objective of public participation -Technique for conflict management and dispute resolution- Verbal communication and Public Hearing in EIA studies - Status of EIA in India - Some typical case studies of EIA industrial and infrastructure projects.	**12L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO 1: Understand the importance & concepts of carrying out EIA.
CO 2: Acquire knowledge about the current EIA process in India.
CO 3: Acquire knowledge about various methods & data requirements for conducting EIA.
CO 4: Analyze Impact's associated with various components of the environment.
CO 5: Plan for mitigation of the impacts & monitor the mitigation measures.
CO 6: Acquire knowledge about Environmental Legislation & Environmental Audit.

Books and References:

1. Larry W. Canter, "Environmental Impact Assessment", Tata Mcgraw Hill Co, Singapore, 1996.
2. R. K. Jain, L. V. Urban & G. S. Stacey, "Environmental Impact Analysis", Van Nostrand Reinhold Company, New York. (1977)
3. R. E. Munn, "Environmental Impact Assessment", John Wiley & Sons, Toronto, 1979.
4. Suresh K. Dhameja, "Environmental Engineering and Management", S. K. Kataria & Sons, Delhi. (2004)
5. Relevant MoEF Notifications and CPCB / GPCB Acts & Rules.

Department of Civil Engineering

Course Name: **Elementary Finite Element Methods**
Course Code: **CE-481**
Course Type: **Stream Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the Finite Element Analysis
- To introduce the fundamental concepts relevant to structural analysis by Finite Element Method.
- To enable the students to understand the factors that cause the economy and optimization of the structural design and construction.
- To study the strain – displacement and linear constitutive relation
- To understand the numerical techniques applied in FEM
- Establishment of element stiffness and load vector
- To study about the 2-D isoparametric concepts
- To analyze the 2-D frame elements using FEM techniques

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction to Finite Element Analysis:** Background of Finite Element Analysis, Numerical Methods, Concepts of Elements and Nodes, Degrees of Freedom.Basic Concepts of Finite Element Analysis: Discretization of Technique Basic, Concepts of Finite Element Analysis, Advantages of FEA, Disadvantages of FEA, Limitations of the FEM, Errors and Accuracy in FEA. Introduction to Elasticity: Strain- Displacement Relations, Linear Constitutive Relations, Two-Dimensional Stress Distribution: Plane Stress Problem, Plane Strain Problem, Axi-symmetric Problem.	**10L**
UNIT-02	**Finite Element Formulation Techniques:** Virtual Work and Variational Principle, Galerkin Method, **Finite Element Method:** Displacement Approach, Choice of Displacement Function, Shape Function, Degree of Continuity, Isoparametric Elements, Various Elements. Stiffness Matrix and Boundary Conditions: Element Stiffness Matrix, Global Stiffness Matrix, Boundary Conditions Natural Coordinates, Triangular Elements, Rectangular Elements, Lagrange and Serendipity Elements, Solid Elements, Isoparametric Formulation, Stiffness Matrix of Isoparametric Elements, Numerical Integration: One Dimensional, Two and Three Dimensional.	**12L**
UNIT-03	**Analysis of Frame Structures:** Stiffness of Truss Members, Analysis of Truss, Stiffness of Beam Members, Finite Element Analysis of Continuous Beam, Plane Frame Analysis, Analysis of Grid and Space Frame	**12L**
UNIT-04	**FEM for Two- and Three-Dimensional Solids:** Constant Strain Triangle, Linear Strain Triangle, Rectangular Elements, Numerical Evaluation of Element Stiffness, Computation of Stresses, Geometric Nonlinearity and Static Condensation, Axi-symmetric Element, Finite Element Formulation of Axi-symmetric Element, Finite Element Formulation for 3 Dimensional Elements	**12L**

Course Outcomes:

On completion of the course, the students will be able to:
Co 1: demonstrate the differential equilibrium equations and their relationship
Co 2: apply numerical methods to FEM
Co 3: demonstrate the displacement models and load vectors
Co 4: compute the stiffness matrix for isoperimetric elements 5. analyze plane stress and plane strain problems

Books and References:

1. Finite element methods, Vol I &Vol II by O.C. Zienkiewicz and R.L. Taylor, McGraw Hill, 1989, 1992.
2. Finite element procedures by K. J. Bathe, PHI Ltd 1996.
3. Concepts and applications of finite element analysis, Third edition by R.D. Cook, D.S. Malkus and M.E. Plesha, , John Wiley and Sons, 1989.
4. Fundamental Finite Element Analysis and Applications: with Mathematica and Matlab Computations by Bhatti, MA., , Wiley, 2005.
5. An Introduction to the Finite Element Method, 3rd Edition, McGraw-Hill Science/Engineering/Math by Reddy, J. N., 2005.
6. A First Course in the Finite Element Method by Logan D. L., Thomson- Engineering, 3rd edition, 2001.
7. Krishnamoorthy, C. S, Finite Element Analysis - Theory and Programming, McGraw - Hill, 1995.
8. David Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
9. G.R. Liu and S.S.Quek, Finite Element Method: A Practical Course, Butterworth-Heinemann; 1st edition (21 February 2003)
10. Chennakesava R. Alavala Finite Element Methods: Basic Concepts and Applications, Prentice Hall Inc., 2010.
11. R. T. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, PHI Learning Pvt Ltd, New Delhi, 1997.
12. S. S. Bhavikatti, Finite Element Analysis, New Age Publishers, 2007.

Department of Civil Engineering

Course Name: **Water Resources Planning & Management**
Course Code: **CE-482**
Course Type: **Stream Elective**
Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the planning and management of water resources.
- To introduce the concepts of watershed management, integrated water resources management, environmental interaction of water resources and policies/framework related to water resources.
- To enable the students to understand the different components of water resources and their management.

Unit Number	Course Content	Contact Hours
UNIT-01	Historical profile on world water resources development; Global water resources, Hydrologic cycle, Watershed zoning, Interrelation of water resources with other natural resources and the environment, Water quantity and water budget, Water allocation and water scheduling; Watershed management, Rainfall-Runoff analysis, Floods measurement, frequency analysis, design of peak flood and routing, Reservoir operation and design.	**10L**
UNIT-02	Water resources availability and demand, Water use sectors – Domestic, Industries and Agriculture, Sustainable water resources development, Integrated Water Resources Management (IWRM), Socio-economic aspects of water resources management, Rainwater Harvesting; Water resource planning – concept, preliminary study, feasibility study, detailed planning, Design of water distribution system, Irrigation scheduling and techniques.	**12L**
UNIT-03	Hydrologic Processes – evaporation, transpiration, and precipitation; Water quality parameters, Water pollution – causes, effects and measures; Global Efforts on Water conservation, Think Globally Act Locally on water resources, Local water organizations, National Water Policy, World water organizations - WUGs, WUAs, UN, WWP, WWC, etc. Environmental discourse on dam Construction.	**12L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify different problems related to water resources planning, management and development.
CO2: Describe problems like water balance, rainfall-runoff analysis, water distribution networks, flood routing, irrigation scheduling, water pollution and other water related concerns.
CO3: Apply principles and guidelines to solve above mentioned problems.

Books and References:

1. Global Water Partnership (GWP), Integrated Water Resources Management, Background Papers No. 4, Technical Advisory Committee (TAC).
2. Water Resources Systems Planning and Management, Vol. 51 by Jain, S.K. and V.P. Singh, Elsevier Science.
3. Hierarchical Analyses of Water Resources Systems: Modeling and Optimization of Largescale systems by Haimes, McGraw-Hill, New York.
4. Water Resources Systems Planning and Management by Loucks D.P. and van Beek E., UNESCO Publishing, The Netherlands.
5. Water Resources Systems Planning and Analysis by Loucks, D.P., J.R. Stedinger, and D.A. Haith, Prentice-Hall, N.J.
6. Hydrosystems Engineering and Management by Mays, L.W. and K. Tung, McGraw-Hill Inc., New York.

Department of Civil Engineering

Course Name: **Computation Techniques in Civil Engineering**
Course Code: **CE-483**
Course Type: **Stream Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To introduce the basic principles, techniques, and applications of soft computing.
- To provide the mathematical background for carrying out the optimization associated with neural network learning.
- To impart the skills of using soft computing in research problems.

Unit Number	Course Content	Contact Hours
UNIT-01	Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, Fuzzy Computing, Neural Computing, Genetic Algorithms; Gene, Chromosome, Allele, Schemata Theory, genotype, phenotype, competition and selection – different types.	**10L**
UNIT-02	Crossover – different techniques, elitism, mutation – different types, stopping criteria, Flow chart of GA. Evolutionary Algorithm: Simulated annealing, Evolutionary programming, Hill climbing.	**10L**
UNIT-03	Fuzzy: Membership function, fuzzification, fuzzy operator, interference rules, defuzzification, exploration and exploitation; Particle Swarm Optimization, Ant colony optimization.	**10L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify the type of algorithm for specific research problem.
CO2: Apply soft computing techniques in research problems.
CO3: Interpret the results obtained from soft computing techniques.

Books and References:

1. Neuro-Fuzzy and Soft Computing by J. S. R. Jang, C. T. Sun and E. Mizutani, Pearson Education.
2. Artificial Neural Network by Simon O. Haykin, PHI.
3. Applications of Soft Computing Techniques in Civil Engineering by S M. Yadav, Viva Books Private Limited

Department of Civil Engineering

Course Name: **Geotechnical Earthquake Engineering**
Course Code: **CE-484**
Course Type: **Stream Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about various types of vibrations and vibrations measuring instruments.
- To enable the students to evaluate wave propagation velocity, dynamic soil properties, ground response, liquefaction potential, dynamic earth pressure.

Unit Number	Course Content	Contact Hours
UNIT-01	**Fundamentals of vibrations:** Earthquake, Type of seismic waves, Magnitude and intensity of earthquake, Response of Single degree of freedom (SDOF) systems to free vibration, exciting forces and ground motions, Experimental determination of natural frequency and damping, Vibration measuring instruments, Vibration isolation, Response of two DOF and Multi degree of freedom systems.	**10L**
UNIT-02	**Wave Propagation:** Waves in Unbounded Media, One-Dimensional Wave Propagation, Three-Dimensional Wave Propagation, Waves in a Semi-infinite Body, Dispersion of Surface Waves, Attenuation of Stress Wave, Material Damping, Radiation Damping**.**	**05L**
UNIT-03	**Dynamic Soil Properties:** Types of dynamic soil properties, Representation of Stress Conditions by the Mohr Circle, Stress Path, Measurement of Dynamic Soil Properties by Field Tests and Laboratory Tests, Stress-Strain Behavior of Cyclically Loaded Soils, Equivalent Linear Model**.**	**05L**
UNIT-04	**Ground Response Analysis:** One-Dimensional Ground Response Analysis by Linear Approach and Nonlinear Approach, Two-Dimensional Ground Response Analysis by Equivalent Linear Approach and Nonlinear Approach, Three-Dimensional Ground Response Analysis.	**05L**
UNIT-05	**Liquefaction and Dynamic Earth Pressure :** Liquefaction-Related Phenomenons, Evaluation of Liquefaction Potential by standard penetration test, Effects of Liquefaction, Dynamic earth pressure of cohesionless and cohesive soil.	**05L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: To know various types of vibrations and vibrations measuring instruments.
CO2: To assess the propagation of waves through different media.
CO3: To evaluate dynamic soil properties and ground response.
CO4: To interpret the liquefaction characteristics of soil in the field.
CO6: To determine the dynamic earth pressure.

Books and References:

1. Dynamics of Structures by A.K. Chopra, Pearson Education
2. Geotechnical Earthquake engineering by S.L. Kramer, Pearson Education
3. Soil Dynamics by Swami Saran Pvt LTD, New Delhi
4. Soil Dynamics by Shamsher Prakash, McGraw Hill Higher Education.
5. Basic and Applied Soil Mechanics by Ranjan & Rao, New Age International Pvt.

Department of Civil Engineering

Course Name: **Fundamentals of Surveying**
Course Code: **CE-310**
Course Type: **Minor Degree**

Contact Hours/Week: 3L Course Credits: **03**

Course Objectives:

- To impart knowledge about the importance, objective and basic principles of surveying.
- To introduce the fundamental concepts of linear, vertical, and directional measurement and use of surveying equipment to collect data needed to develop topographical maps, traverses, and profiles.

Unit Number	Course Content	Contact Hours
UNIT-01	Introduction to surveying: plane and geodetic surveys, errors in measurements, maps, scales, plotting accuracy, topographic maps	**05L**
UNIT-02	Linear measurements: Direct and indirect methods, Chain and tape measurements, Optical methods- tacheometers, Electronic methods- EDMs/Total Station.	**05L**
UNIT-03	Vertical Measurement: Levelling and Contouring.	**05L**
UNIT-04	Measurement of directions: Compass surveying, Theodolites surveying.	**05L**
UNIT-05	Plane tabling	**05L**
UNIT-06	Modern Surveying methods: GPS, Remote sensing, GIS.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1 Acquire fundamental understanding of the engineering principles underlying surveying,
CO2 Understand and use surveying equipment ordinarily employed in surveying,
CO3 Data-gathering task that will ensure data meets the quality requirements of positioning.

Books and References:

1. Surveying–Vol 1 & 2 by K.R.Arora.
2. Plane Surveying by A. M.Chandra.
3. Surveying–Vol 1 & 2 by B.C. Punmia, Ashok K. Jain, Arun K. Jain,
4. Surveying: Theory and Practice by J.M. Anderson and E.M. Mikhail.

Department of Civil Engineering

Course Name: **Civil Engineering Materials and Construction**
Course Code: **CE-320**
Course Type: **Minor Degree**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the civil engineering material and construction
- To introduce the fundamental concepts relevant to properties of materials and their application
- To enable the students to understand the factors that differentiate materials and accordingly their applications

Unit Number	Course Content	Contact Hours
UNIT-01	**Building Stones:** Classification of stones- Characteristics of good building stones, important types of building stones, their properties and stones and uses. **Brick:** Composition of brick-earth, manufacturing process of bricks, characteristics of good building bricks, classification and testing of bricks, special types of bricks and their uses. **Cement:** Composition, manufacture, Classification and applications, properties and IS specifications and tests, rate of hydration, special types, **Fine and Coarse aggregate:** Source, Impurities, Classification, and Characteristics. Sand - properties; **Timber:** Classification of timber trees, cross section of exogenous tree, hard wood and soft wood, Classification, seasoning, defects, wood product and its applications.	**10L**
UNIT-02	**Cement concrete and Special concrete:** Types, Properties of fresh and hardened concrete, test methods, proportioning of concrete mixes; Concrete construction - batching, mixing, placing, compacting, and curing of concrete, form work; Precast concrete and pre-stressed concrete; Recent developments in concreting; Iron and steel - Structural sections, properties and uses of structural steel; Recent developments in steel and concrete.	**8L**
UNIT-03	**Structural Components of building and building specification:** **Foundation:** bearing capacity of soils, improvement of bearing capacity , settlement of foundation ; Type, application, Description of spread, grillage, raft and pile foundations; **Masonry Construction:** Masonry construction using stones, bricks and other building blocks. Specifications for building stone, commonly used stones in masonry construction. Testing and preservation of stones. Bonds in masonry construction. Types, Bonds, defects. Different types of mortars used in masonry construction **Walls:** Types of load bearing and non-load bearing walls, Cavity walls ; Partition walls ; **Floor and Roofs:** type, Ground/Upper: Flat /Slopped. Beam/Band-Plinth, Sill, Lintel -Types and details, Stairs, Ramps - classification, application; **Form work:** Requirements, Load applied, Scaffolding. **Lintels and arches Floors and roofs- different types – flooring and roofing materials ;** **Doors, windows & ventilators:** Different types of doors, windows & ventilators. Ventilation: Functional requirement, Systems	**10L**
UNIT-04	**Non-Structural Components of building and building specification** **Building Finishes and Maintenance:** Plastering, pointing, Distempering, Color washing, and Painting. **Damp proofing anti- termite treatment and Water Proofing**: Causes, Prevention Methods, damp-proofing treatment, Materials used; Roof treatments for water proofing. **Fire Protection:** Fire safety requirement, fire extinguishing equipment.	**08L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify and describe construction material, structural and non-structural components
CO2: Apply principles of compatibility of material and construction methods
CO3: Assess the suitability and functional aspect of the materials and construction methodology

Books and References:

1. Building Materials by S.K. Duggal, New Age Int. Publishers.
2. Building Materials by P.C.Varghese, PHI
3. Building Construction by B.C.Punmia Ashok Kumar Jain & Arun Kumar Jain, Laxmi Publication
4. Shetty, M. S., Concrete Technology, S.Chand & Co., New Delhi, 1992.

Department of Civil Engineering

Course Name: **Environmental Engineering**
Course Code: **CE-410**
Course Type: **Minor Degree**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To understand the necessity of environmental engineering.
- To know the basic of water quality & the concept of implementing standards.
- To know the basic of waste water.
- To basics of air pollution

Unit Number	Course Content	Contact Hours
UNIT-01	**Demand and Sources of Water:** Water demand - Population forecast - Water quality requirements - Sources and its yield for water requirements- Intake structures – Water quality parameters and their significance in domestic use.	**10L**
UNIT-02	**Water Treatment:** Design of treatment units such as aeration, sedimentation, coagulation and flocculation, filtration, Disinfection, water softening- Advanced water treatment methods.	**08L**
UNIT-03	**Waste water Generation, Collection & Conveyance:** Wastewater Quantity - Classification of wastewater - Sewerage system for domestic wastewater and storm water - Collections, and appurtenances - Design and layout of sewerage systems - Maintenance of sewerage systems - Physical, Chemical & Biological characteristics and their significance.	**10L**
UNIT-04	**Sources and effects of air pollutants:** Classification of air pollutants – Particulates and gaseous pollutants – Sources of air pollution – Source inventory – Effects of air pollution on human beings, materials, vegetation, animals – global warming-ozone layer depletion, Sampling and Analysis – Basic Principles of Sampling – Source and ambient sampling – Analysis of pollutants – Principles	**08L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Understand the basic concepts and analyze the requirements of a water supply project.
CO2: Experimentally analyze the water quality of an area and understand the need of safe and pure water.
CO3: Understand the basic concepts and analyze how to dispose of the sewage in an environment friendly manner.
CO4: Understand the nature and characteristics of air pollutants and air quality.

Books and References:

1. Water Supply Engineering by S.K. Garg, Khanna Publishers.
2. Water Supply & Pollution Control by Warren ViessmanJr, Mark J. Hammer &Elizabeth Perez, PHI
3. Rao M.N., and Rao H. V. N., Air Pollution Control, Tata McGraw Hill, New Delhi, 1996.
4. Water Works Engineering by Syed R. Qasim, Edward M. Motley, GuangZhu,PHI
5. Sewage Disposal & Air Pollution Engineering by S.K. Garg, Khanna Publishers.

Course Name: **Construction Project Management**
Course Code: **CE-420**
Course Type: **Minor Degree**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about types, merit, and demerits of construction contracts,
- To introduce the fundamental concepts relevant to CPM and PERT, and
- To enable students to understand organizational structures in the construction industry

Unit Number	Course Content	Contact Hours
UNIT-01	**Construction Management:** Significance, objectives and functions, resources for construction industry, stages in construction, Civil Engineering drawings.	**05L**
UNIT-02	**Construction Contracts & Specifications:** Types of contracts, contract document, specifications, important conditions of contract, arbitration.	**05L**
UNIT-03	**Construction Organization:** Principles of organization, communication in organization, types of organizations, temporary services, job layout.	**05L**
UNIT-04	**Construction Planning:** Work breakdown structure, pre-tender stage planning, contract stage planning, scheduling, bar charts, limitations of bar charts, milestone charts, preparation of material, equipment, labor, and finance schedule	**05L**
UNIT-05	**Critical Path Method:** Network techniques, element of a network, rules for developing networks, development logics, numbering events, time computations, activity floats, network updating. Resources profile, resources smoothing and resources leveling.	**05L**
UNIT-06	**Cost-Time Analysis:** Cost versus time, direct cost, indirect cost, total project cost, optimum duration, contracting network for cost optimization.	**05L**
UNIT-07	**Program Evaluation and Review Technique:** Probability concept in network, optimistic time, pessimistic time, most likely time, variance, standard deviation, slack, central limit theorem. probability of achieving completion time.	**06L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Understand purpose, types, merit, and demerits of construction contracts, CO2: Develop organizational structures in the construction industry,

CO3: Develop critical path method-based network and estimate various times and floats, and

CO4: Develop PERT network and find probability of completion of a project in specified duration.

Books and References:

1. Construction Planning & Management by P.S. Gehlot & B.M. Dhir
2. PERT & CPM -Principles & Applications by L.S. Srinath.
3. Project Planning & Control with PERT & CPM by B.C. Punmia & K.K. Khandelwal,
4. Construction Management & Planning by B. Sengupta & H. Guha,
5. Project Management: Planning and Scheduling Techniques by Bansal, V. K., Routledge: Taylor& Francis Group.

Department of Civil Engineering

Course Name: **Building Materials and Construction**
Course Code: **CE-301**
Course Type: **Open Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the civil engineering material and construction
- To introduce the fundamental concepts relevant to properties of materials and their application
- To enable the students to understand the factors that differentiate materials and accordingly their applications

Unit Number	Course Content	Contact Hours
UNIT-01	**Building Stones:** Classification of stones- Characteristics of good building stones, important types of building stones, their properties and stones and uses. **Brick:** Composition of brick-earth, manufacturing process of bricks, characteristics of good building bricks, classification and testing of bricks, special types of bricks and their uses. **Cement:** Composition, manufacture, Classification and applications, properties and IS specifications and tests, rate of hydration, special types. **Fine and Coarse aggregate:** Source, Impurities, Classification, and Characteristics. Sand - properties. **Timber:** Classification of timber trees, cross section of exogenous tree, hard wood and soft wood, Classification, seasoning, defects, wood product and its applications.	**10L**
UNIT-02	**Cement concrete and Special concrete:** Types, Properties of fresh and hardened concrete, test methods, proportioning of concrete mixes; Concrete construction - batching, mixing, placing, compacting, and curing of concrete, form work; Precast concrete and pre-stressed concrete; Recent developments in concreting; Iron and steel - Structural sections, properties, and uses of structural steel; Recent developments in steel and concrete.	**8L**
UNIT-03	**Structural Components of building and building specification:** **Foundation:** bearing capacity of soils, improvement of bearing capacity, settlement of foundation; Type, application, Description of spread, grillage, raft, and pile foundations. **Masonry Construction:** Masonry construction using stones, bricks, and other building blocks. Specifications for building stone, commonly used stones in masonry construction. Testing and preservation of stones. Bonds in masonry construction. Types, Bonds, defects. Different types of mortars used in masonry construction. **Walls:** Types of loads bearing and non-load bearing walls, Cavity walls; Partition walls; **Floor and Roofs:** type, Ground/Upper: Flat /Slopped. Beam/Band-Plinth, Sill, Lintel -Types and details, Stairs, Ramps - classification, application. **Form work:** Requirements, Load applied, Scaffolding. **Lintels and arches Floors and roofs- different types – flooring and roofing materials.** **Doors, windows & ventilators:** Different types of doors, windows & ventilators. Ventilation: Functional requirement, Systems	**10L**
UNIT-04	**Non-Structural Components of building and building specification** **Building Finishes and Maintenance:** Plastering, pointing, Distempering, Color washing, and Painting. **Damp proofing anti- termite treatment and Water Proofing**: Causes, Prevention Methods, damp-proofing treatment, Materials used; Roof treatments for water proofing. **Fire Protection:** Fire safety requirement, fire extinguishing equipment.	**08L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify and describe construction material, structural and non-structural components.
CO2: Apply principles of compatibility of material and construction methods
CO3: Assess the suitability and functional aspect of the materials and construction methodology

Books and References:

1. Building Materials by S.K. Duggal, New Age Int. Publishers.
2. Building Materials by P.C.Varghese, PHI
3. Building Construction by B.C.Punmia Ashok Kumar Jain & Arun Kumar Jain, Laxmi Publication
4. Shetty, M. S., Concrete Technology, S.Chand & Co., New Delhi, 1992.

Department of Civil Engineering

Course Name: **Disaster Management**
Course Code: **CE-302**
Course Type: **Open Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the disaster Management …
- To introduce the fundamental concepts relevant to various aspect of disaster
- To enable the students to understand the factors that causes the disaster…

Unit Number	Course Content	Contact Hours
UNIT-01	**Understanding Disasters:** Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management Types, Trends, Causes, Consequences and Control of Disasters: Geological Disasters; Hydro-Meteorological Disasters, Biological Disasters and Man -made Disasters Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters.	**06L**
UNIT-02	**Disaster Management Cycle and Framework:** Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro-zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR, Yokohama Strategy, Hyogo Framework of Action.	**12L**
UNIT-03	**Disaster Management in India:** Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state, and national), Non-Government and Inter-Governmental Agencies.	**06L**
UNIT-04	**Applications of Science and Technology for Disaster Management:** Geo-informatics in Disaster Management (RS, GIS, GPS, and RS) Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development Regulations Disaster Safe Designs and Constructions Structural and Non-Structural Mitigation of Disasters S&T Institutions for Disaster Management in India.	**12L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Identify the types of disaster.
CO2: Describe disaster.
CO3: Apply principles of management.
CO4: Assess the solution for handling disaster.

Books and References:

1. Manual on natural disaster management in India by M C Gupta, NIDM, New Delhi
2. Encyclopedia of disaster management, Vol I, II and IIIL Disaster management policy and Administration by S L Goyal, Deep & Deep, New Delhi,
3. Management of Natural Disasters in developing countries by H.N. Srivastava & G.D. Gupta, Daya Publishers, Delhi,
4. Disaster Management Act 2005, Publisher by Govt. of India
5. Publication of National Disaster Management Authority (PNDMI) on Various Templates and Guidelines for Disaster Management

Department of Civil Engineering

Course Name: **Air Pollution Control**
Course Code: **CE-303**
Course Type: **Open Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives
- To understand the sources, characteristics, and effects of air pollutants
- To know the methods of controlling air pollution

Unit Number	Course Content	Contact Hours
UNIT-01	Sources and effects of air pollutants - Classification of air pollutants – Particulates and gaseous pollutants – Sources of air pollution – Source inventory – Effects of air pollution on human beings, materials, vegetation, animals – global warming-ozone layer depletion, Sampling and Analysis – Basic Principles of Sampling – Source and ambient sampling – Analysis of pollutants – Principles	**10L**
UNIT-02	Dispersion of air pollutants - Elements of atmosphere – Meteorological factors – Wind roses – Lapse rate – Atmospheric stability and turbulence – Plume rise – Dispersion of pollutants – Dispersion models – Applications.	**10L**
UNIT-03	Air Pollution Control - Concepts of control – Principles and design of control measures – Particulates control by gravitational, centrifugal, filtration, scrubbing, electrostatic precipitation – Selection criteria for equipment – gaseous pollutant control by adsorption, absorption, condensation, combustion – Pollution control for specific major industries	**16L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: understand the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management
CO2: identify, formulate, and solve air and noise pollution problems.
CO3: design stacks and particulate air pollution control devices to meet applicable standards

Books and References:

1. Anjaneyulu, D., "Air Pollution and Control Technologies", Allied Publishers, Mumbai, 2002.
2. Rao, C.S. Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 1996.
3. Rao M.N., and Rao H. V. N., Air Pollution Control, Tata McGraw Hill, New Delhi, 1996.
4. Mahajan S.P., "Pollution Control in Process Industries", Tata McGraw Hill Publishing Company, New Delhi, 1991.

Department of Civil Engineering

Course Name: **CPM and PERT**
Course Code: **CE-304**
Course Type: **Open Elective**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

To introduce the fundamental concepts relevant to project scheduling
To impart knowledge about the basic principles of CPM and PERT
To enable the students to find probability of completion of a project in a specified duration

Unit Number	Course Content	Contact Hours
UNIT-01	**Project Planning:** Work breakdown structure, scheduling by bar charts, limitation of bar charts, milestone charts, and multiple calendar date scheduling using bar chart.	**06L**
UNIT-02	**Network Techniques in Project Management-I (CPM):** Introduction with network techniques, classification of activities, rules for developing networks, network development-logic of network, numbering events, network analysis, determination of project schedules, critical path, floats in activities, updating, resources allocation, resources smoothing and resources leveling.	**12L**
UNIT-03	**Network Techniques in Project Management-II (PERT):** Probability concept in network, optimistic time, pessimistic time, most likely time, lapsed time, deviation, variance, standard deviation, slack critical path, probability of achieving completion time, central limit theorem.	**10L**
UNIT-04	**Cost-Time Analysis:** Cost versus time, direct cost, indirect cost, total project cost and optimum duration, contracting the network for cost optimization, steps in time cost optimization.	**08L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1: Develop bar-chart based schedule and understand its limitations,
CO2: Develop critical path method (CPM) based network and estimate various times and floats,
CO3: Understand the implementation of network technique,
CO4: Develop PERT based network and find probability of completion of a project in a specified duration, and
CO5: Understand time-cost relationship for projects.

Books and References:

1. Project Management: Planning and Scheduling Techniques by Bansal, V. K., Routledge: Taylor & Francis Group
2. Project Planning and Control with PERT and CPM by B.C. Punmia and K.K. Khandelwal.
3. Project Management Technique in Planning and Controlling Construction Projects by H.N. Ahuja.
4. Construction Project Management: Planning, Scheduling and Control by K.K. Chitkara.
5. Project Management with CPM, PERT and Precedence Diagramming by J. Moder, C. Phillips and E. Davis.
6. PERT and CPM -Principles and Applications by L.S. Srinath.

Department of Civil Engineering

Course Name: **Engineering Graphics**
Course Code: **CE-101**
Course Type: **Institute Core**

Contact Hours/Week: **1L + 2P** Course Credits: **02**

Course Objectives:

- To know and practice basic drafting skills.
- To be able to understand the designs of structures or machine parts.
- To be able to visualize the projected drawings and present various projections on the sheet.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction**: Drawing instruments and their uses, Types of lines, Lettering, General rules for dimensioning, Geometrical constructions using instruments.	**01L**
	Orthographic Projection: Methods of projection, Principles of Orthographic projection, First angle versus third angle of projection, Six views of an object.	**02L**
	Isometric Projections: Isometric views of simple solids.	**01L**
UNIT-02	**Projection of Points**: Projections of points when they are situated in different quadrants.	**01L**
	Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces.	**02L**
UNIT-03	**Projections of Planes**: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.	**02L**
	Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes.	**02L**
UNIT-04	**Section of Solids**: Sectional planes, Sectional views of prism and pyramid.	**01L**

Course Outcomes:

Upon successful completion of the course, the students will be able to

CO1 Know the basic drafting tools

CO2 Understand the designs of structures and machine parts

CO3 Practice visualization.

Books and References:

1. Bhatt, N. D. and Panchal, V.M, Engineering Drawing, Charotar Publishing House