Scheme of Examination for B.Tech. (Civil Engineering) Degree Course - Semester - V

Course No.	Course Title	Teaching Schedule per week				Credits
		L	T	P/D	Total	
CEPC301	Geotechnical Engineering - I	3	0	0	3	3
CEPC302	Water Supply & Treatment	3	0	0	3	3
CEPC303	Engineering Hydrology	3	0	0	3	3
CEPC304	Design of Concrete Structures - I	3	0	2	5	4
CEPC305	Geotechnology (P)	0	0	2	2	1
CEPC306	Environmental Engg. - I (P)	0	0	2	2	1
CEPE301-306	Programme Elective - II (Seminar)	0	1	0	1	1
OE	Open Elective - I	3	0	0	3	3
SWNC101	NCC/Sports/Yoga	0	0	2	2	1*
SWNC102	NSS/Clubs/Technical Societies	0	0	2	2	1*
	Total	**15**	**1**	**10**	**26**	**19**

*Continuous evaluation model as per guidelines and the credit to be awarded at the end of 6th semester based on cumulative performance up to 6th semester

Scheme of Examination for B.Tech. (Civil Engineering) Degree Course - Semester - VI

Course No.	Course Title	Teaching Schedule per week				Credits
		L	T	P/D	Total	
CEPC307	Transportation Engineering - I	3	0	0	3	3
CEPC308	Sewerage & Sewage Treatment	3	0	0	3	3
CEPC309	Irrigation Engineering - I	3	0	0	3	3
CEPC310	Design of Steel Structures - II	3	0	2	5	4
CEPC311	Transportation Engineering - I (P)	0	0	2	2	1
CEPC312	Environmental Engg. - II (P)	0	0	2	2	1
CEPE307-327	Programme Elective - III (Theory)	3	0	0	3	3
OE	Open Elective - II	3	0	0	3	3
SWNC101	NCC/Sports/Yoga	0	0	2	2	1
SWNC102	NSS/Clubs/Technical Societies	0	0	2	2	1
	Total	**18**	**0**	**10**	**28**	**23**

*The students would undergo industrial training/internship of 6 - 8 weeks during summer vacation after 3rd year, which would be evaluated in the VII semester by assessing the report and seminar presentation. Attachment with academic institution of repute is also permitted.

Scheme of Examination for B.Tech. (Civil Engineering) Degree Course - Semester - VII

Course No.	Course Title	Teaching Schedule per week				Credits
		L	T	P/D	Total	
MEIC416	Entrepreneurship and Start-ups	3	0	0	3	3
CEPC401	Transportation Engineering - II	3	0	0	3	3
CEPC402	Industrial Waste Water Treatment	2	0	0	2	2
CEPC403	Design of Concrete Structures - II	3	0	2	5	4
CEPC404	Transportation Engineering - II (P)	0	0	2	2	1
CEPE401-406	Programme Elective - IV (Project-I)	0	0	4	4	2
OE	Open Elective - III	3	0	0	3	3
CEIC401	Industrial Training/Internship	0	0	0	0	3
	Total	**14**	**0**	**8**	**22**	**21**

Scheme of Examination for B.Tech. (Civil Engineering) Degree Course - Semester - VIII

Course No.	Course Title	Teaching Schedule per week				Credits
		L	T	P/D	Total	
CEPC405	Construction Management, Estimating and Costing	3	0	0	3	3
CEPC406	Railway & Airport Engineering	3	0	0	3	3
CEPC407	Irrigation Engineering - II	3	0	0	3	3
CEPC408	Geotechnical Engineering - II	3	0	0	3	3
CEPE407-412	Programme Elective - V (Project-II)	0	0	6	6	3
OE	Open Elective - IV	3	0	0	3	3
	Total	**15**	**0**	**6**	**21**	**18**

B.Tech. (Civil Engineering) - Syllabi of various courses

CEPC301 Geotechnical Engineering - I

Pre-requisite: Soil Mechanics

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course is designed to provide students with the knowledge of various criteria of design of shallow foundations and provide skills for soil exploration techniques. It will help students to understand action of a single pile and piles in group, and methods of calculations of load capacity by various techniques including lateral stability of well foundations.

Course Content:

Unit-I (12 hrs)

Earth pressure: Introduction, earth pressure at rest, Rankine's active & passive states of plastic equilibrium, Rankine's earth pressure theory, Coulomb's earth pressure theory, Culmann's graphical construction, Rebhann's construction.

Sub-Surface exploration: Purpose, stages in soil exploration, depth and lateral extent of exploration, guidelines for various types of structures, ground water observations, excavation and boring methods, soil sampling and disturbance, major types of samplers, sounding methods - SCPT, DCPT, SPT and interpretation, geophysical methods, exploration log.

Unit-II (12 hrs)

Shallow Foundations: Situation suitable for the shallow foundation, types of shallow foundations, factors influencing depth and location of a footing, ultimate bearing capacity, modes of shear failure, Rankine's analysis, Terzaghi's theory, Skempton's formula, effect of fluctuation of GWT, effect of eccentricity on bearing capacity, inclined load, I.S Code recommendations, factors affecting bearing capacity, methods of improving bearing capacity, various causes of settlement of foundation, safe bearing pressure based on settlement, settlement calculation, elastic and consolidation settlement, allowable settlement as per IS Code, plate load test and its interpretation, bearing capacity from penetration tests, conventional procedure of proportioning of footings, raft foundations, bearing capacity of raft in sands and clays, floating foundation.

Unit-III (6 hrs)

Pile Foundations: Introduction, necessity of pile foundations, classification of piles, load capacity, static analysis, analysis of pile capacity in sands and clays, dynamic analysis, pile load tests, negative skin friction, under-reamed piles, group action in piles, pile spacing, pile group capacity, stress on lower strata, settlement analysis, negative skin friction of pile group.

Unit-IV (6 hrs)

Well foundations - components, shapes, forces acting on well foundations, factors governing depth, load carrying capacity in sands and clays, lateral stability, procedure for construction of wells, tilts and shifts.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Basic and Applied Soil Mechanics by Gopal Ranjan and A S R Rao
2. Soil Engineering in Theory and Practice, Vol. 1, Fundamentals and General Principles by Alam Singh
3. Principles of Foundation Engineering by Braja M Das
4. Soil Mechanics and Foundations by Muni Budhu
5. Advanced Foundation Engineering by V N S Murthy

Course Outcomes:

On completion of the course, the students shall be able to:

CO1	Understand the importance of soil investigation for civil engineering projects.
CO2	Understand earth pressure theories and calculate lateral earth pressure for different conditions.
CO3	Calculate allowable bearing pressure of soil for the design of shallow foundations.
CO4	Evaluate the load capacity of a pile and piles in group by various techniques.
CO5	Design well foundations and understand methods to rectify tilts and shifts during construction of wells.

CEPC302 Water Supply & Treatment

Pre-requisite: Applied Chemistry & Basics of Fluid Mechanics

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course:
The course is designed to provide students knowledge and skills necessary for planning and designing water supply and treatment systems for safe and adequate water supply to the community. The course covers a wide range of topics, including water quantity, water quality characterization, treatment methods and distribution systems.

Course Content:

Unit-I **(9 Lectures)**

Water Quantity and Collection

Importance and necessity of water supply scheme. Components of water supply scheme, water demands and its variations. Population forecasting, estimation of total quantity of water requirement, quality and quantity perspective of surface and ground water sources, selection of a source for water supply, Intakes-types of intakes, factors governing location of intakes, pumps and pumping stations.

Unit-II

Water Quality **(7 Lectures)**

Sources of impurities, type of impurities in water and their sanitary significance, physical, chemical and bacteriological analysis of water, sampling, water quality standards.

Unit-III **(11 Lectures)**

Water Treatment

Objectives, treatment processes and their sequence in conventional water treatment plant, aeration, sedimentation – plain and aided with coagulation- types, features and design aspects, mixing basins and flocculation units. Filtration – mechanisms, types of filters - slow and rapid sand filtration units (features and design aspects), disinfection - theory, methods and practices, specific water treatment methods

Unit-IV **(9 Lectures)**

Water Conveyance and Distribution

Hydraulic design of pressure pipe, pipe materials, types of distribution system – gravity system, pumping system, dual system, layout of distribution system – dead end system, grid iron system, ring system, radial system, their merits and demerits, distribution reservoir - functions and determination of storage capacity, hydraulic analysis of distribution network. Indigenous and sustainable technologies/practices related to water supply and treatment, case studies on water supply and treatment systems.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Water Supply and Sewerage: E.W. Steel.
2. Water Supply Engineering: S.R. Kshirsagar.

3. Water Supply Engineering: S.K. Garg.
4. Water Supply Engineering: B.C. Punmia.
5. Environmental Engineering: Peavy H. S., Rowe D. R. and Tchobanoglous G.
6. Introduction to Environmental Engineering: Davis M. L. and Cornwell D. A.
7. Water Supply and Sanitary Engineering: Birdie, G. S. and Birdie
8. Manual on Water Supply and Treatment: Ministry of Urban Dev., New Delhi.

Course Outcomes:

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

CO1: Estimate water quantity requirements and decide components of water supply scheme

CO2: Understand and analyze various water quality parameters

CO3: Design various water treatment units

CO4: Design water conveyance distribution system

CEPC303 Engineering Hydrology

Pre-requisite: Fluid Mechanics - I & Fluid Mechanics - II

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: Students will be able to understand and measurement techniques of various hydrologic data required for water resources projects.

Course Content:

Unit-I (9 hrs)

1. Introduction
   Hydrologic cycle, scope and application of hydrology to engineering problems, drainage basins and its characteristics, stream geometry, hypsometric curves.
2. Precipitation
   Forms and types of precipitation, characteristics of precipitation in India, measurement of precipitation, recording and non-recording raingages, raingage station, raingage network, estimation of missing data, presentation of rainfall data, mean precipitation, depth -area -duration relationship, frequency of point rainfall, intensity -duration-frequency curves, probable max. precipitation.

Unit-II (7 hrs)

3. Evaporation & Transpiration
   Process, evaporimeters and empirical relationships, analytical method, reservoir evaporation and methods of its control, transpiration, evapotranspiration and its measurement, Penman's equation and potential evapotranspiration.

4. Infiltration
   Infiltration process, initial loss, infiltration capacity and measurement of infiltration, infiltration indices.

Unit-III (11 hrs)

5. Runoff
   Factor affecting run-off, estimation of runoff, rainfall-run off relationships, measurement of stage-staff gauge, wire gauge, automatic stage recorder and stage hydrograph, measurement of velocity-current meters, floats, area velocity method, moving boat and slope area method, electromagnetic, ultra-sonic and dilution methods of stream flow measurement, stage discharge relationship.
6. Hydrograph
   Discharge hydrograph, components and factors affecting shape of hydrograph, effective rainfall, unit hydrograph and its derivation, unit hydrograph of different durations, use and limitations of UH, triangular UH, Snyder's synthetic UH, floods, rational methods, empirical formulae, UH method, flood frequency methods, Gumbel's method, graphical method, design flood.
7. Flood Routing
   Introduction, reservoir routing and channel routing, Modified Pul’s method, Muskingum method of routing, Flood control

Unit-IV (9 hrs)

8. Ground Water
   Occurrence, types of aquifers, compressibility of aquifers, water table and its effects on fluctuations, wells and springs, movement of ground water, Darcy's law, permeability and its determination, porosity, specific yield and specific retention, storage coefficient, transmissibility. Steady state flow to wells in unconfined and confined aquifers.
9. Sustainable use of water and conservation
   Need, methods, water efficient technologies
   .

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Engineering Hydrology by K Subramanya.
2. Hydrology by H M Raghunath.
3. Hydrology for Engineers by Linsely, Kohler, Paulhus.
4. Elementary Hydrology by V P Singh.

Course Outcomes:

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

CO1: know Hydrologic cycle & precipitation types

CO2: be familiar with measurement techniques of various components of hydrologic cycle

CO3: know concept of flood estimation.

CO4: be acquainted with the aquifer characteristics and ground water yield

CEPC304 Design of Concrete Structures-I

L	T	P/D	Credits	Total contact hours
3	0	2	4	5

Pre-requisite: Structural Analysis

Brief description of the course: The course has been designed to introduce the students to properties of concrete and reinforcement to be used for structural design of various members. This will create interest among students in designing various structural members used in RCC buildings, viz. beams, columns, slabs and foundations.

Course Content:

Unit 1. Limit State Design Method: Building code IS 456-2000, Limit state of collapse, serviceability, characteristic strength and characteristics loads, design values, Partial safety factors, stress -strain relationship for concrete and steel. Limit state of collapse: flexure, Shear, Basic assumptions, Analysis and design of singly, doubly reinforced rectangular sections. (8 lectures)

Unit 2. T beams and Continuous beams: Bending Moments and Shear forces in Continuous beams, Structural Design as per IS 456-200, Design of T beams and continuous beams. (8 lectures)

Unit 3. Design of Slabs: One way and Two Way Slabs, General considerations, Design of continuous one way and two way slabs for distributed loadings as per IS 456-2002 for different end conditions. (6 lectures)

Unit 4. Design of Columns: Limit state of Collapse; Compression, Effective length, Minimum eccentricity, short columns under axial compression, Uniaxial and biaxial bending, slender compression members. (6 lectures)

Unit 5. Design of Footings: Isolated footings, Combined footings, Raft foundation. (8 lectures)

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Design of Reinforced Concrete Structures, P Dayaratnam, Oxford & IBH Pub., N. Delhi.
2. Reinforced Concrete-Limit State Design, A. K. Jain, Nem Chand & Bros., Roorkee.
3. Compressive RCC design, B C Punmia, Ashok Kumar Jain, Anil Kumar Jail, Laxmi Publications.
4. SP-16(S&T)-1980, 'Design Aids for Reinforced Concrete to IS:456, BIS, N. Delhi.
5. SP-34(S&T)-1987 'Handbook on Concrete Reinforcement and Detailing', BIS, N. Delhi.

Course Outcomes:

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

CO1	Limit state design for RCC Beams and slabs.
CO2	Structural Design of columns for RCC framed buildings.
CO3	Design one way and two way slabs
CO4	design considerations for design of column and footings.

CEPC305 Geotechnology (P)

Pre-requisite: Soil Mechanics, Geotechnical Engineering - I

L	T	P/D	Credits	Total contact hours
0	0	2	1	2

Brief description of the course: The course is designed to provide students skills for determination of shear strength parameters and compressibility of soils, for conducting field testing for bearing capacity determination and use of computational techniques and softwares to solve geotechnical problems.

Course Content:

1. Consolidated Drained (CD) Triaxial Test.
2. Consolidated Undrained (CU) Triaxial Test with Pore Water Pressure Measurement.
3. Consolidation Test.
4. Undisturbed Sampling.
5. Standard Penetration Test.
6. Dynamic Cone Penetration Test.
7. Laboratory Plate Load Test.
8. Model Pile Load Test.
9. Use of MATLAB/C language/Excel to solve Geotechnical Engineering problems.
10. Exposure to Geotechnical Softwares.

Text Books/Reference:

1. Soil Engineering in Theory and Practice, Vol. II, Geotechnical Testing and Instrumentation by Alam Singh.
2. Soil testing for engineers by S Prakash & P K Jain.
3. Engineering soil testing by Lambe.
4. Engineering properties of soils and their measurement by J E Bowles.
5. Compendium of Indian Standards on Soil Engineering, SP: 36 (Part I) - 1987, BIS.
6. Compendium of Indian Standards on Soil Engineering, SP: 36 (Part II) - 1988, BIS.

Course Outcomes:

On completion of the course, the students shall be able to:

CO1. Estimate soil design parameters for estimation of shear strength and compressibility.

CO2. Conduct field testing for bearing capacity determination.

CO3. Use computational techniques and softwares to solve Geotechnical problems.

CEPC306 Environmental Engineering - I (P)

Pre-requisite: Water Supply & Treatment

L	T	P/D	Credits	Total contact hours
0	0	2	1	2

Brief description of the course:
The course is designed to provide students' knowledge and skills necessary for analyzing physical, chemical and bacteriological characteristics of water and determining chemical dose for water treatment.

Course Content:

1. To determine the pH value of a given water sample
2. To determine the turbidity of a given water sample
3. To determine the conductivity of a given water sample
4. To determine the chloride concentration in a given sample of water
5. To determine the optimum coagulant dose
6. To determine the temporary and permanent hardness in a given water sample.
7. To determine free residual chlorine in a given sample of water
8. To determine the chlorine dose required for a given water sample
9. To determine the dissolved oxygen (DO) in a given sample of water.
10. To determine the MPN coliform per 100 ml of a given sample of water
11. To determine the total plate count of a given water sample
12. Microscopic studies of water

Text Books/Reference:

1. Water Supply Engineering: S.K. Garg.
2. Environmental Engineering: Peavy H. S., Rowe D. R. and Tchobanoglous G.
3. Chemistry for Environmental Engineering: Sawyer, C.N., McCarty, P.L., Parkin, G.F.
4. Standard Methods for the Examination of Water and Wastewater, 22nd Edition, 2012

Course Outcomes:
Upon successful completion of the course, the students will be able to
CO1: Apply various analytical techniques for physical and chemical characterization of water
CO2: Quantify the level of impurities in water and recommend necessary degree of treatment
CO3: Determine dose of coagulant and chlorine necessary for water treatment
CO4: Assess the microbial contamination of water

CEPC307 Transportation Engineering - I

Pre requisite: Geotechnical Engg. - I, Surveying - I

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description about the course: The course is about understanding the importance of transportation, characteristics of road transport, highway planning, alignment and road surveys. The course also details the geometric design of the highways. The course includes study analysis and design of traffic characteristics, traffic control devices and principles of signal/intersection design.

Unit- I: **8 hrs**

1. Introduction

Transportation and its importance. Different modes of transportation. Brief review of history of road development in India and abroad. Road patterns. PMGSY and other Highway projects

2. Highway Plans, Highway Alignment and Surveys

Road development plans in India. Classification of roads. Requirements of an ideal highway alignment. Factors affecting alignment. Engineering surveys for highway alignment.

Unit -II: **12 hrs**

3. Cross Section Elements and Sight Distance Considerations

Cross section elements, Camber, IRC recommended values. Sight distance: stopping sight distance, overtaking sight distance, overtaking zones, intermediate sight distance, sight distance at intersections, Critical locations for sight distance.

4. Design of Horizontal and Vertical Alignment

Design of superelevation. Providing superelevation in the field. Radius of circular curves. Extra-widening. Length of transition curves. Gradient, Summit and Valley curves, their design criteria. Introduction to software like MXROAD.

Unit – III: **8 hrs**

5. Traffic Characteristics and Traffic Surveys

Traffic characteristics. Traffic volume, speed, O & D study, Parking and Accident studies. Fundamental diagram of traffic flow. Level of service. PCU. Capacity for non-urban roads. Road accidents. Introduction to Road Safety Audit

6. Traffic Control Devices

Traffic signs, signals, markings and islands. Design of an isolated fixed time signal by IRC method. Intersections at grade and grade separated intersections. Design of a rotary. Traffic pollution.

Unit -IV: **8 hrs**

7. Highway Materials: Soil and Aggregate

Subgrade soil evaluation: CBR test, plate bearing test. Desirable properties of aggregates. Various tests for suitability of aggregates. Proportioning of aggregates for road construction by trial-and-error method.

8. Bituminous Materials and Bituminous Mixes

Types of bituminous materials: bitumen, tar, cutback and emulsions. Various tests for suitability of bitumen. Bituminous mix, desirable properties. Marshall' method of mix design. Basic concept of use of polymers and rubber modified bitumen in bituminous mixes, use of waste plastic in bituminous mixes.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Khanna, S.K. and Justo, C.E.G., Veeraragavan A., "Highway Engineering", Nem Chand & Bros.
3. Kadiyali, L.R., "Traffic Engineering and Transportation Planning", Khanna Publishers.
4. Jotin Khisty, C. and Kent Lall, B., "Transportation Engineering – An Introduction", Prentice Hall.
5. G.V.Rao, Principles of Transportation and Highway Engg, Tata McGraw Hill Pub.
6. Principles of Transportation Engg, P. Chakroborty & Animesh Dass, Prentice Hall of India, 2003.

Course Outcomes:

CO1: Gain Engineering knowledge of the subject and apply it for the solution of problems related to highway engineering.
CO2. Design geometrics, signals and intersections, make investigations, use modern tools and develop solutions to highway problems including safety of road users.
CO3. Understand the engineering solutions in societal and environmental context for sustainable development that takes care of pollution and environment.
CO4. Understand the norms of engineering practice and the need for life-long learning as per their exposure to relevant latest IS/IRC/MoRTH specifications.

CEPC308 Sewerage & Sewage Treatment

Pre-requisite: Applied Chemistry

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course:
The course is designed to provide students with the knowledge and skills necessary to design sewerage system and treat sewage safely and effectively for disposal and reuse for various purposes. The course covers a wide range of topics, including sewage collection, characterization, treatment methods, and regulatory requirements.

Course Content:

Unit-I (10 lectures)
Collection of Sewage
Importance of sanitation, types of sewerage systems – separate, combined and partially separate, quantity of sanitary sewage and variations, shapes of sewer - circular and egg shaped, design of sewers, self-cleansing velocity and slopes, construction and testing of sewer lines, sewer materials, joints and sewer appurtenances, building drainage and plumbing systems.

Unit-II (6 lectures)
Sewage Characterization
Physical, chemical and biological characterization, BOD concept and computation, Indian Standards for disposal of effluents into sewerage system, inland surface water sources and on land, disposal of sewage by dilution - self-purification of streams - Streeter Phelps equation - oxygen sag curve, sewage disposal by irrigation (sewage treatment).

Unit-III (14 lectures)
Sewage Treatment
Objectives, sequence and efficiencies of conventional treatment units, preliminary treatment, screening and grit removal units, theory and design aspects of primary treatment, secondary treatment- activated sludge process & its modifications, tricking filter, UASB process, introduction to advance sewage treatment systems - sequencing batch reactor (SBR)-moving bed biofilm reactor (MBBR)-membrane bioreactor (MBR), Stabilization pond, aerated lagoon, septic tank, sludge disposal – thickening-digestion-dewatering.

Unit-IV (6 lectures)
Recycling, Reuse and Indigenous Sustainable Techniques
Introduction of tertiary treatment, recycling and reuse of treated wastewater, guidelines for reuse of treated wastewater. Indigenous and sustainable technologies/techniques for sewerage system and sewage treatment using local resources, such as - wastewater drainage and management system of Indus Valley Civilization, decentralized sewage treatment plants to accommodate varying degrees of the operational scale – eco-industrial parks, bioremediation and phytoremediation, sewage treatment using biomimicry of natural functional principles and strategies of microorganisms and ecosystem of ruminants' stomach.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible

sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Environmental Engineering: Peavy H. S., Rowe D. R. and Tchobanoglous G.
2. Introduction to Environmental Engineering: Davis M. L. and Cornwell D. A.
3. Wastewater Engineering, Collection, Treatment and Disposal: Metcalf and Eddy
4. Water Supply and Sanitary Engineering: Birdie, G. S. and Birdie
5. Sewage and Sewage Treatment: S.K. Garg.
6. Sewerage and Sewage Treatment: S. R. Kshirsagar.
7. Waste Water Engineering: B.C. Punmia.
8. Manual on Sewerage and Sewage Treatment: Ministry of Urban Dev., New Delhi.

Course Outcomes:

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

CO1: Estimate quantity of sewage and design sewerage system.
CO2: Determine the various characteristics of sewage.
CO3: Design various sewage treatment units.
CO4: Plan reuse of treated effluent and select appropriate disposal option.

CEPC309 Irrigation Engineering - I

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: To provide the basics of availability of water, crops, irrigation types and methods used. To impart knowledge about canals design theories used in irrigation projects, water logging concepts, drainage systems details, different river training methods and outlets used in irrigation channels.

Course Content:

Unit-I (10 hrs)

1 **Introduction:**

Irrigation-necessity, advantages, disadvantages, impact of irrigation on human environment, need and historical development of irrigation in India, National water policy, Haryana state water resources, crops and crop seasons, ideal cropping pattern and high yielding varieties of crops.

2 **Soil-water relationship and irrigation methods:**

Soil-water relationship, root zone soil water, infiltration, consumptive use, field capacity, wilting point, available moisture in soil, GCA, CCA, intensity of irrigation, delta, base period, Kor depth, core period, frequency of irrigation, duty of water, relation between delta, duty and base period, irrigation requirement, flooding methods, border strip method, check basin and furrow method, assessment of irrigation water, sprinkler irrigation, favourable conditions, sprinkler systems, hydraulics of sprinkler irrigation, planning, design and maintenance of sprinkler systems, drip irrigation-components parts, advantages and limitations, suitability of drip irrigation.

Unit-II (7 hrs)

3 **Canal irrigation:**

Components of canal distribution system, alignment of channels, losses in irrigation channels, design discharge, silt theories and design of alluvial channels, comparison of Kennedy's and Lacey's theories, canal section and design procedure, Garrets and Lacey's diagrams, measurement of discharge in channels,.

Unit-III (7 hrs)

4 **Water logging and land reclamation:**

Water logging-effects, causes and measures of prevention, lining of irrigation channels, types of lining, design of lined channel land drainage, open drains, design considerations, advantages of tile drains, depth of tile drains, layout of closed drains, discharge and spacing of closed drains, diameter of tile drain, outlets for tile drains, maintenance of tile drains, purpose of land reclamation and methods of land reclamation, Quality of irrigation water for irrigation

Unit-IV (7 hrs)

5 **River Training:**

Classification of rivers, river training and its objectives, classification of river training works, methods of river training, marginal embankments, guide anks, spurs, cutoffs,

bank pitching and launching apron, application of Geo-synthesis and other materials for river training works

Unit- V (5 hrs)

6 **Canal outlets:**
Classification, requirements of a good outlet, design of pipe, APM and open flume outlet, flexibility proportionality, setting and sensitivity of outlet.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1 Arora K R, "Irrigation Water Power & Water Resources Engineering" Standard Publishers Distributors, Delhi, (2011).
2 Asawa G L, "Irrigation Engineering" Wiley Eastern Ltd., New Delhi, (1993).
3 Asawa, G. L. "Irrigation and Water Resources Engineering", New Age International, New Delhi. (2014).
4 Garg, S. K. "Irrigation Engineering and Hydraulic Structures", Khanna Publishers, New Delhi. (2011).
5 Michael. A.M "Irrigation-Theory & Practice" Vikas Publishing House Pvt Ltd N Delhi II edition (2011)
6 Modi P.N., "Irrigation, Water Resources and Water Power Engineering" Standard Book Publishing Company, 9th Edition N Delhi (2014).
7 Murthy, C.S.N." Water Resources Engineering – Principles and Practice", New Age International Publishers, N Delhi (2020),
8 Singh Bharat, "Fundamentals of Irrigation Engineering" Nem Chand & Brothers, Roorkee, (1975).

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: Estimate the Irrigation Requirements of Crops
CO2: Ascertain the suitable methods for water application in the field.
CO3 Identify the distribution systems for canal irrigation and the basics of design of unlined and lined irrigation canals.
CO4: Design a Land Drainage System for a given problem
CO5: Understand in detail about river training works, its types and canal outlets.

CEPC310 Design of Steel Structures - II

Pre-requisite: Structural Analysis - I, Design of Steel Structures - I

L	T	P/D	Credits	Total contact hours
3	0	2	4	5

Brief description of the course: The course is designed to provide students with the knowledge of analysis of steel beams and frames using plastic method. The introduction of steel design code and its application in the design of steel structures, i.e. roof trusses, steel water tanks, steel stacks, and stiffened, unstiffened, moment-resistant connections.

Course Content:

UNIT-I

1. **Elementary Plastic Analysis and design:**
   Introduction, Scope of plastic analysis, ultimate load carrying capacity of tension members and compression members, flexural members, shape factor, mechanisms, plastic collapse, analysis, plastic analysis applied to steel beams. [6]
2. **Connections:**
   Types of connections (bolted and welded), design of framed connections, design of unstiffened and stiffened seated connections, moment-resistant beam end connections. [6]

UNIT-II

3. **Design of Water Tanks:**
   Introduction, permissible stresses, circular and pressed steel tank design including staging. [10]

UNIT-III

4. **Design of Steel Stacks:**
   Introduction, various loads to be considered for the design of steel stacks, design of steel stacks including the foundation. [7]

UNIT-IV

5. **Roof Trusses:**
   Types and Components of a roof truss, introduction to wind load, estimation of wind load, load combinations, design of purlins with and without sag rods, lateral bracing, design of roof truss. [7]

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Design of Steel Structures, A S Arya & J. L. Ajmani, Nem Chand & Bros., Roorkee.
2. Design of Steel Structures, P. Dayartnam, Wheeler Pub. Allahabad.
3. Design of Steel Structures, Gaylord & Gaylord, McGraw Hill, New York/International Students Edn., Toyo Kogakusha, Tokyo.
4. IS:800-2007, Indian Standard Code of Practice for General Construction in Steel.
5. SP6 (1)-1964, IS handbook for structural Engineers. Bureau of Indian Standards, New Delhi.
6. IS 875 Part (3)-2015, Code of Practice or Design Loads (other than earthquake) for buildings and structures: wind loads, Bureau of Indian Standards, New Delhi.

Course Outcomes: On completion of the course, the students shall be able to

CO1. Analyze beams using plastic analysis.
CO2. Design various components of roof trusses including purlins.
CO3. Design steel tanks.
CO4. Design steel stacks.
CO5. Design unstiffened, stiffened, moment-resistant connections.

CEPC311 Transportation Engineering - I (P)

Pre requisite: Geotechnical Engineering - I

L	T	P/D	Credits	Total contact hours
0	0	2	1	2

Brief description about the course: The course is about understanding basic properties of subgrade soil, aggregates and bitumen used in the construction of pavements. The course incorporates the testing procedure of subgrade soil, aggregates and bituminous materials.

Course Content:

1. Aggregate Impact Test on aggregates
2. Los-Angeles Abrasion Test on Aggregate
3. Crushing Strength Test on Aggregate
4. Flakiness and Elongation Index of aggregates
5. Penetration Test on Bitumen
6. Ductility Test on Bitumen
7. Viscosity Test on Bituminous Material
8. Softening Point Test on Bitumen
9. Flash and Fire Point Test on Bitumen
10. CBR lab test on soil

Text Books/Reference:

1. Khanna, S.K. and Justo, C.E.G., Veeraragavan A., "Highway Engineering", Nem Chand & Bros.
2. Khanna, S.K. and Justo, C.E.G., "Highway Material Testing Manual", Nem Chand & Bros.
3. Kadiyali, L.R., "Traffic Engineering and Transportation Planning", Khanna Publishers.
4. G.V.Rao, Principles of Transportation and Highway Engg, Tata McGraw Hill Pub.
5. Principles of Transportation Engg, P. Chakroborty & Animesh Dass, Prentice Hall of India, 2003.

Course Outcomes:

CO1: Understand important aggregates properties from road construction point of view
CO 2. Understand properties of Bitumen binder
CO 3. Understand behaviour of subgrade soil through CBR test
CO 4. Understand the norms of engineering practice and the need for life-long learning as per their exposure to relevant latest IS/IRC/MoRTH specifications.

CEPC312 Environmental Engineering - II (P)

Pre-requisite: Applied Chemistry

L	T	P/D	Credits	Total contact hours
0	0	2	1	2

Brief description of the course:
The course is designed to provide students with the knowledge and skills necessary to analyze the physical, chemical and bacteriological characterization of municipal sewage and/or wastewater.

Course Content:
Physical, chemical and bacteriological characterization of wastewater and strength assessment of wastewater by performing following laboratory experiments:

1. To determine the acidity of a wastewater sample.
2. To determine the alkalinity of a wastewater sample.
3. To determine total, suspended, dissolved and settable solids in a wastewater sample.
4. To determine volatile and fixed solids in a wastewater sample.
5. To determine oil and grease in a wastewater sample.
6. To determine the chloride concentration in a wastewater sample.
7. To determine the sulphate concentration in a wastewater sample.
8. To determine the B.O.D. of a given wastewater sample.
9. To determine the C.O.D. of a given wastewater sample.
10. To determine the T.O.C. of a given wastewater sample.
11. To determine the fecal count of a given wastewater sample.
12. Microscopic studies of a wastewater.

Text Books/Reference:

1. Standard Methods for the Examination of Water and Wastewater, 22nd Edition, 2012
2. Sawyer, C.N., McCarty, P.L., Parkin, G.F., Chemistry for Environmental Engineering, Tata McGraw-Hill, 2000.
3. Pelczar, M. J. (Jr), Chan, E C S and Krief, N. R., Microbiology, 5th Ed., McGraw-Hill, 1996
4. Metcalf and Eddy Inc, Wastewater Engineering: Treatment and Reuse, TMH publication, 4th Edition, 2003.

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

CO1: Apply different analysis techniques for the measurement of physical and chemical parameters of wastewater.
CO2: Quantify the pollutant concentration in wastewater.
CO3: Recommend the degree of treatment required for the wastewater.
CO4: Assess the microbial population in wastewater.

CEPC401 Transportation Engineering - II

Pre requisite: Transportation Engineering - I

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description about the course: This course is to learn the designing of flexible and rigid pavements. The course also follows the learning of construction techniques of highway pavements. To learn the pavement failures and maintenance of pavements including strengthening. To learn how to evaluate highway projects and sources of financing. To learn the modern equipment for traffic studies and pavement evaluation. Mix designing of granular, bituminous and CC mixes.

UNIT-I **12 hrs**

1. Design of Flexible Pavements

Types of pavements. Flexible and rigid pavements. Components of a pavement and their functions. Factors affecting design of pavements. Review of design by old methods, Design of a flexible pavement by CBR method (as per latest IRC guidelines).

2. Design of Rigid Pavements

Westergaard's theory, critical locations of loading, load and temperature stresses. Critical combination of stresses. IRC guidelines for determination of thickness of a rigid pavement. Joints: requirements, types, patterns. Spacing of expansion and contraction joints. Functions of dowel and tie bars.

UNIT-II **8 hrs**

3. Highway Construction: Non-Bituminous Pavements

Subgrade and embankment construction, Construction of GSB, WBM, WMM. Construction of DLC & PQC. Fixed form and Slip-form paving techniques.

4. Construction of Bituminous Pavements

Various types of bituminous constructions. Prime coat, tack coat, seal coat and surface dressing. Construction of BUSG, Premix carpet, BM, DBM and BC. Mastic asphalt. Brief introduction to functions of Rollers, paver and hot mix plants. Introduction to various IRC and MoRTH specifications.

UNIT-III **8 hrs**

5. Highway Maintenance

Failures and remedies of bituminous and cement concrete pavements. Pavement evaluation. Benkleman beam. Introduction to various types of overlays. Overlay design.

6. Highway Drainage and Hill Roads

Surface drainage: types, brief design. Types of sub-surface drainage. Special characteristics of hill roads: geometrics, hair pin bends.

UNIT-IV **8hrs**

7. Highway Economics and Finance

Need of economic evaluation. Highway user benefits and costs. Methods of economic evaluation, Highway finance. PPP Projects. Rate analysis of MoRTH standard data book & cost estimation.

8. Tunnels

Sections of tunnels, Shaft. Pilot tunnel. Driving tunnel in rocks. Driving tunnel in soft ground. Drainage and Ventilation of Tunnels.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Highway Engg by S.K.Khanna & C.E.G. Justo, Veeraragavan A., Nem Chand Bros., Roorkee, 2014.
2. Principles and Practice of Highway Engg. by L.R.Kadiyali, N.B. Lal, Khanna Publishers, Delhi, 2008.
3. Principles of Pavement Design by Yoder,E.J & Witczak,M.W., John Wiley and Sons, USA.
4. Tunnel Engineering by S.C.Saxena, Dhanpat Rai Publications, N.Delhi.
5. A text book of Tunnel, Bridges and Railway Engg. by S.P.Bindra, Dhanpat Rai Delhi.

Course Outcomes:

CO1. Gain Engineering knowledge of the subject and apply it for the solution of problems related to pavement engineering.
CO2. Design flexible and rigid pavements, make investigations, use modern tools and develop solutions to problems related to highway pavements.
CO3. Understand the engineering solutions in societal context for sustainable development that takes care of environment and economical use of resources.
CO4. Understand the norms of engineering practice and the need for life-long learning as per their exposure to relevant latest IS/IRC/MoRTH specifications.

CEPC402 Industrial Waste Water Treatment

Pre-requisite: Sewerage and Sewage Treatment

L	T	P/D	Credits	Total contact hours
2	0	0	2	2

Brief Description about the course

This course contains general standards for discharge of industrial pollutants. It includes various treatments consisting of preliminary, primary, secondary and tertiary process for treatment of industrial waste water. It also includes manufacturing process, waste generation, quality and treatment of specific Industries.

Course Content:

Unit - I **(5 hrs.)**

Composition of an industrial effluent:

Difference between Domestic and Industrial Wastewater, zero liquid discharge (ZLD) concept, Measurement of Polluting parameters and their effects on water bodies, sewerage systems and wastewater treatment plants, General standards for discharge of industrial pollutants into inland surface water, sewerage systems, on land, common effluent treatment plant (CETP).

Unit - II **(5 hrs.)**

Control and removal of specific pollutants in industrial wastewaters:

General Flow sheet for treatment of industrial waste water. Unit processes and operations to remove oil and grease, cyanide, fluoride, toxic organics, heavy metals, radioactivity substances and other pollutants.

Unit - III **(5 hrs.)**

Treatment for industrial wastewater:

Equalization and Proportioning, Neutralization, Waste Reduction and minimization techniques, Volume Reduction and Strength Reduction, Secondary and tertiary treatment for industrial wastewater, Eco-industrial parks

Unit - IV **(9 hrs.)**

Case Studies on Industries

Brief overview of manufacturing process, waste generation, quality and treatment of specific Industrial wastewater: Dairy, Pulp and Paper, Tanneries, Textiles, Sugar mill, Metal plating, Fertilizer industry.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, McGraw Hill Education, 2017, 4th Edition
2. Industrial Waste Water Pollution Control by W' Wesley Eckenfelder - McGraw-Hill
3. Wastewater Treatment, Rao, M.N., and Dutta, A.K., IBH Publ., 1995
4. Handbook of Industrial Pollution and Control, Volume I & II: S. C. Bhatia
5. Pollution Control in Process Industries: S. P. Mahajan.
6. Industrial and Hazardous Waste Treatment: N. L. Nemerow and A. Dasgupta.

7. Industrial Wastewater Management, Treatment and Disposal, WEF Manual of practice No. FD-3, 3rd Ed., WEF Press and McGraw Hill, 2008
8. Industrial Waste Water Treatment, Patwardhan, A.D., PHI Learning, 2009.
9. Industrial Effluents by N. Manivasakam
10. Industrial Wastewater Treatment, Recycling and Reuse, Vivek Ranade Vinay Bhandari, Elsevier Publications, 2014.

Course outcomes:

On completion of the course, the students will be able to

CO1: Recognize various environmental problems due to improper management of industrial wastewater.

CO2: Determine appropriate technologies for treatment and management of industrial wastewater.

CO3: Recommend different techniques for the safe disposal of industrial effluents.

CO4: Analyze the quality requirements for reuse of industrial effluents.

CEPC403 Design of Concrete Structures - II

Pre-requisite: Structural Analysis and Design of Concrete Structures - I

L	T	P/D	Credits	Total contact hours
3	0	2	4	5

Brief Description about the course: The course has been designed to introduce the students to the analyze the behaviour the different massive structures. The course creates interest among the students for the analysis and design of the elements other than regular structural elements. The course covers the discussion related to behaviour, analysis and design of Flat Slab, Earth retaining Structures, Water Retaining Structures and Prestressed Structures.

Course Content:

1. Flat slabs

Advantages of flat slabs, general design considerations, approximate direct design method, design of flat slabs, openings in flat slab

Design of staircases

Design of various types of staircases, design examples (8 lectures)

2. Earth Retaining Structures

Classification, Forces on retaining walls, design criteria, stability requirements, proportioning of cantilever retaining walls, counterfort retaining walls, criteria for design of counterforts, design examples. (6 lectures)

3. Water Retaining Structures

Design requirements of water retaining structures, rectangular and cylindrical underground, and overhead tanks, Intze tanks, design considerations for tanks, design examples.

(8 lectures)

4. Analysis of Prestressed Concrete Elements

Introduction, Basic concepts, materials, various Pre-tensioning and Post-tensioning systems, concept of losses, Stress calculations, and concept of cable profile (6 lectures)

5. Design of Prestressed concrete Elements

Design of post tensioned prestressed concrete simply supported rectangular and flanged sections for flexure and shear including end block.

Design of one way and two way post tensioned slabs (Single panel only). (8 lectures)

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Plain and Reinforced Concrete, Vol.2, Jai Krishna & O. P. Jain, Nem Chand & Bros., Roorkee.
2. Pre-Stressed Concrete, N. Krishna Raju, TMH Pub., N. Delhi.
3. Reinforced Concrete Design, U. Pillai and D. Menon, Tata McGraw-Hill New Delhi.

4. Design of Prestressed Concrete Structures, T. Y. Lin, John Wiley & Sons., N. Delhi.
5. Reinforced Concrete-Limit State Design, A. K. Jain, Nem Chand & Bros., Roorkee.
6. IS 1343-1980, IS Code of Practice for Prestressed Concrete.
7. IS 3370-1976 (Part I to IV), Indian Standard Code of Practice for Liquid Retaining Structures.
8. IS 456-2000, Indian Standard of Practice for Plain and Reinforced Concrete.
9. IS 1893, 4326 & 13920 Indian Standard Code of Practice for Earthquake Resistant Design of Structures.

Course Outcomes: On completion of the course, the students shall be able to

CO1 Design of flat slabs and staircase.
CO2 Design earth retaining Structures.
CO3 Design water retaining Structures.
CO4 Design prestressed members.

CEPC404 Transportation Engineering - II (P)

Pre requisite: Transportation Engineering - I & II**,** Transportation Engineering - I (P)

L	T	P/D	Credits	Total contact hours
0	0	2	1	2

Brief description about the course: The course is about understanding basic properties of aggregates and bitumen used in the construction of pavements. The course incorporates exposure to granular, bituminous and concrete mix designs. Students shall be able understand various tools used for traffic volume study, speed study and an introduction to pavement structural and functional evaluation.

Course Content:

1. Specific gravity and water absorption test on coarse aggregate
2. Specific gravity of bitumen
3. Stripping test on aggregates
4. Determination of bitumen content and gradation of bituminous mix
5. Granular Mix Design
6. Bituminous Mix Design by Marshall's method
7. Cement concrete mix design for pavements
8. Traffic volume and speed study using videography technique
9. Demonstration of Radar Gun & Automatic Counter Classifier
10. Demonstration of BBD & Bump Integrator

Text Books/Reference:

1. Highway Engg by S.K.Khanna & C.E.G. Justo, Veeraragavan A., Nem Chand Bros., Roorkee, 2014.
2. Principles and Practice of Highway Engg. by L.R.Kadiyali, N.B. Lal, Khanna Publishers, Delhi, 2008.

Course Outcomes:

CO1. Gain Engineering knowledge of the subject and apply it for judging the suitability of highway related to pavement engineering.
CO2. Understands mix design for granular, bituminous and cement concrete mixes
CO3. Understand the norms of engineering practice and the need for life-long learning as per their exposure to relevant IS/IRC specifications.

CEPC405 Construction Management, Estimating and Costing

Pre-requisite: Building Construction and Materials

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course covers the properties of ingredients of concrete, concrete design mix, behaviour of concrete at its fresh and hardened state, procedures in concreting and special concrete and their uses.

Course Content:

Unit-I (15 hrs)
Planning, scheduling and Project Management: Planning stages, construction schedules and project specification, monitoring and evaluation; Bar-chart, CPM, PERT, network-formulation and time computation.
CPM: Introduction, network techniques, work break down, classification of activities, rules for developing networks, network development-logic of network, allocation of time to various activities, Fulkerson's rule for numbering events, network analysis, determination of project schedules, critical path, ladder construction, float in activities, shared float, updating, resources allocation, resources smoothing and resources leveling.
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.
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, illustrative examples.

Unit-II (9 hrs)
Preparation of detailed estimates - Principles of estimation, units, items of work, different types of estimates, different methods of estimation, estimation of materials in single room building, two roomed building with different sections of walls, foundation, floors and roofs, R.B. and R.VC.C. works, Plastering, White-washing, Distempering and painting, doors and windows, lump sum items, Estimates of canals, roads etc.
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 colour washing, distempering, painting.
Preparation of specifications report accompanying the estimate, Approximate methods of Costing - types of estimates - costing for various structures - rate analysis - rate for material and labour - schedule of rates –data sheets - abstract estimate.

Unit-III (4 hrs)
Introduction, function of P.W. department, Tender and acceptance of tender, Earnest money, security money, retention money, measurement book, cash book, preparation, examination and payment of bills, first and final bills, administrative sanction, technical sanction.

Unit-IV (8 hrs)
Contracts: Types of contracts, Formation of contract – Contract conditions – Contract for labour, material, design, construction- Drafting of contract documents based on IBRD/

MORTH Standard bidding documents- Construction contracts - Contract problems - Arbitration and legal requirements. Computer applications in construction management: Software for project planning, scheduling and control.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Construction Planning & Management by P. S. Gehlot & B. M. Dhir, Wiley Eastern Ltd.
2. PERT & CPM -Principles & Applications by L. S. Srinath. Affiliated East-west Press (P) Ltd.
3. Project Planning & Control with PERT & CPM by B. C. Punmia & K. K. Khandelwal, Lakshmi Pub. Delhi
4. Construction Management & Planning by B. Sengupta & H. Guha, Tata McGraw Hills.
5. Estimating and Costing for Building & Civil Engg. Works by P. L. Bhasin, S. Chand & Co., N. Delhi.
6. Estimating, Costing & Specification in Civil Engg. by M. Chakarborty, Calcutta.
7. Estimating & Costing in Civil Engg.: Theory & Practice by B. N. Dutta, S. Dutta & Co. Lucknow.
8. Building Construction Estimating by George H. Cooper, McGraw Hill Book Co., New York.

Course Outcomes:

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

CO1: Apply different types of estimates in different situations

CO2: Carry out analysis of rates and bill preparation at different locations

CO3: Demonstrate the concepts of specification writing

CO4: Compute construction schedules, network diagrams and time estimates of projects

CO5: Use the computer software to monitor real-time projects

CEPC406 Railway and Airport Engineering

Pre requisite: Transportation Engineering-I & II

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description about the course:
The course of railway and airport engineering is to understand the permanent way and its components. To know about points, crossing, and train control systems. To understand the geometric design of track, about stations, yards and maintenance of tracks, to learn airport layout planning and runway pavement design.

Course Content:

Unit-I **10 hrs**

Introduction of Permanent Way
History and general features of Indian railways, Railway Track Gauge, Rails, Sleepers, Track fittings and fastenings, Creep of rails, Ballast, Subgrade and formation, Rail joints and welding of rails, modern welded railway track, Track and Track stresses.

Unit-II **8 hrs**

Stations and Yards, Points and Crossings, and Signalling
Stations and yards, Points and crossings, design of turnouts and crossings, Signalling and interlocking, Train Control systems, Track maintenance and drainage.

Unit-III **10 hrs**

Geometric Design of Track, High speed train systems
Geometric design of track, curves and super elevation, Train resistance and tractive power, Urban Railway system, High speed Tracks, high speed train system technologies, Introduction to RDSO/IS specifications.

Unit-IV **8 hrs**

Airport Planning, Runway Layout and Pavement Design
Airport planning, layout, geometric design, Airport pavements, introduction to runway pavement design software like FAARFIELD

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Chandra, S. and Agarwal, M. M., "Railway Engineering", Oxford.
2. Arora, S. P. and Saxena, S. C., "A Text Book of Railway Engineering", Dhanpat Rai Publications.
3. Mundrey, J. S., "Railway Track Engineering", Tata McGraw Hill.
4. Khanna, S. K., Arora, M. G. and Jain, S. S., "Airport Planning & Design", Nem Chand and Bros.
5. Horonjeff, Robert and McKelvey, Francis X., "Planning & Design of airports', 4th Ed., McGraw Hill.
6. Saxena, S.C., "Airport Engineering - Planning and Design", CBS Publishers.

7. Transportation Engineering by C Venkatramaiah

Course Outcomes:

CO1. Gain Engineering knowledge of the subject and apply it for the solution of problems related to railway and airport engineering.

CO2. Design points and crossings, design runway pavements, make investigations, use modern tools and develop solutions to problems related to railway / airport engineering.

CO3. Understand the engineering solutions in societal context for sustainable development that takes care of environment and optimal use of resources.

CO4. Understand the norms of engineering practice and the need for life-long learning as per their exposure to relevant latest IS/RDSO/FAA/ICAO specifications.

CEPC407 Irrigation Engineering - II

Pre-requisite: Irrigation Engineering - I

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: To inculcate the essentials of hydraulic structures like canal falls, regulators (Cross & head), cross drainage works, diversion headworks. Gravity dams, earth dams and spillways used in the Civil Engineering projects. To demonstrate various concepts/methods in detail along with design Hydraulic structures.

Course Content:

Unit-I (9 hrs)

1 **Regulation works:**

Canal falls-necessity and location, development of falls, design of cistern element, roughening devices, design of Sarda type fall, design of straight Glacis fall. Off-take alignment, cross-regulator and distributary head regulators, devices to control silt entry into the off-taking channel and silt ejector, canal escapes, types of escapes.

Unit-II (6 hrs)

2 **Cross drainage works:**

Classification and their selection, hydraulic design aspects of aqueducts, syphon aqueducts, super passage, canal syphon and level crossing, design of transitions.

Unit-III (6 hrs)

3 **Diversion canal headworks:**

Various components and their functions, layout plan, weirs and Barrages, selection of site for diversion headworks, Bligh's creep theory, Lane theory, Khosla's method of independent variables with corrections, use of Khosla's curves, various corrections, silt excluders.

Unit-IV (8 hrs)

4 **Storage Headworks:**

Types of dams, selection of a site, gravity dam-two dimensional design, forces acting, stability criterion, elementary profile of a dam, cutoffs and drainage galleries.

Earth dam, types, design principles, seepage through earth dams, seepage line, causes of failures, stability analysis, control of seepage, design of filters.

Unit-V (7 hrs)

5 **Spillways and Energy Dissipators:**

Essential requirements of spillway and spillway's capacity, types of spillways and their suitability with functions, design of Ogee spillways, energy dissipation below spillways, stilling basins, USBR and I.S. Stilling Basins.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible

sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1 Arora K R, "Irrigation Water Power & Water Resources Engineering" Standard Publishers Distributors, Delhi, (2011).
2 Creager, W. P., Justin, J. D. W., and Hinds, J. "Engineering for Dams, Nem Chand Publications, Roorkee. (1995).
3 Garg, S. K. "Irrigation Engineering and Hydraulic Structures", Khanna Publishers, New Delhi. (2011).
4 Khatsuria, R. M. "Hydraulics of Spillways and Energy Dissipators", CRC Press. (2004).
5 Modi P.N., "Irrigation, Water Resources and Water Power Engineering" Standard Book Publishing Company, 9th Edition N Delhi (2014).
6 Murty C S, "Design of Minor Irrigation and Canal Structures" Wiley Eastern Ltd. New Delhi. (1986)
7 Varshney, R. S., Gupta, S. C., and Gupta, R. L. "Theory and Design of Irrigation Structures", Vol. II, Nem Chand Publications, Roorkee. (2007)

Course Outcomes:

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

CO1: To plan and design the regulation structures.

CO2: To select a suitable cross-drainage works in a given situation and its complete design

CO3: Describe and interpret knowledge related to diversion headworks along with theories,

CO4: Analyze the factors affecting and able to design of gravity dam and earth dam.

CO5: To understand spillways & energy dissipation systems and able to design

CEPC408 Geotechnical Engineering - II

Pre-requisite: Soil Mechanics, Geotechnical Engineering - I

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This course will help students to understand the concept of earth dam design including slope stability analysis under different drainage conditions. It will impart knowledge to students about the analysis and design of earth retaining structures. It will help students to understand salient points of environmental engineering pertaining to Geotechnology.

Course Content:

Unit-I (11 hrs)

Earth dams: Introduction, types of sections, causes of failure and criteria for safe design, control of seepage through the embankment, control of seepage through the foundation, criterion for filter design.

Stability of slopes: Causes of failure, factors of safety, stability analysis of slopes-total stress analysis, effective stress analysis, stability of infinite slopes, types of failures of finite slopes, analysis of finite slopes-mass procedure, method of slices, effect of pore pressure, Fellinius method to locate center of most critical slip circle, friction circle method, Taylor's stability number.

Unit-II (8 hrs)

Cantilever sheet piles: Purpose of sheet piles, cantilever sheet piles, depth of embedment in granular soils, cantilever sheet pile penetrating clay.

Anchored bulkheads: Methods of design, free earth support method in cohesionless and cohesive soils, fixed earth support method in cohesionless soils.

Unit-III (10 hrs)

Braced cuts: Depth of unsupported vertical cut, sheeting and bracing for deep excavation, movements associated with sheeting and bracing, modes of failure of braced cuts, stability of bottom of a cut, pressure distribution behind sheeting.

Cofferdams: Introduction, types of cofferdams, design data for cellular cofferdams, stability analysis of cellular cofferdams on soil and rock.

Unit-IV (7 hrs)

Environmental Geotechnology: Introduction, environmental cycles, natural cycles, development of environmental geotechnology, pollution process, contamination of sub-soil, contaminant transport, quantity of contaminants, contaminated site characterization, composition of solid wastes, waste containment.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Analysis and Design of Foundation and Retaining Structures by S Prakash, Gopal Ranjan & S Saran
2. Analysis and Design of Sub Structures by Swami Saran
3. Basic and Applied Soil Mechanics by Gopal Ranjan
4. Foundation Design by Teng

5. Geotechnical Engineering by S K Gulhati & M Datta

Course Outcomes:

On completion of the course, the students shall be able to:

CO1	Do earth dam design and carry out slope stability analysis.
CO2	Evaluate depth of embedment for cantilever and anchored sheet piles.
CO3	Design and carry out stability analysis of braced cuts and cellular cofferdams.
CO4	Understand salient points of environmental Geotechnology.

Programme Elective - III (Theory)

CEPE307 Advanced Design of Steel Structures

Pre-requisite: Structural analysis, Steel structures

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course is designed to provide the knowledge of structural design of various types of steel structures as per Indian standards. Also, students would be able to design complete steel structure in addition to component design and its behaviour under loading.

Course Content:

UNIT-I

1. Introduction to plastic analysis and design, plastic bending of beams, stages of bending, shape factor, plastic hinge, load factor, failure mechanism - Theorems of plastic analysis, collapse load for beams and frames, design of continuous beams. [9]

UNIT-II

2. Design of tubular structures - Introduction, sectional properties, permissible stresses, grades of steel tubes, tubular tension members, tubular compression members, tubular flexural members, combined bending and axial stresses. [5]

3. Beam-column-Introduction, bending about one axis, bending about both axes, boundary constraints, design of beam-columns. [4]

UNIT-III

4. Cold-Formed Sections-Introduction and a brief description of various types of cold formed sections, local buckling, concepts of effective width and effective sections, elements with stiffeners, design of compression, and stiffened, unstiffened bending elements. [9]

UNIT-IV

5. Composite construction - Introduction, composite beams, method of construction, limit state of collapse, limit state of serviceability, design examples. [9]

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

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. Krishnaraju, N. Structural Design and Drawing, Universities Press, 2009
4. IS 800 - 2007, Code of practice for general construction in steel, Bureau of Indian Standards, New Delhi.
5. SP6 (1)-1964, IS handbook for structural Engineers. Bureau of Indian Standards, New Delhi.

6. IS 875 Part (3)-2015, Code of Practice or Design Loads (other than earthquake) for buildings and structures: wind loads, Bureau of Indian Standards, New Delhi.

Course Outcomes: On completion of the course, the students shall be able to

1. Design beams and portal frames using plastic analysis.
2. Design tubular tension, compression, and flexural members.
3. Design cold formed light gauge structural members.
4. Design composite beams.

CEPE308 Dynamics of Structures

Pre-requisite: Knowledge of Structural and Earthquake Analysis

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This course will focus on characterizing the behaviour of structures subject to dynamic loads (e.g., earthquake, impact, blast). Structures would be idealized to simplified single-degree-of-freedom (SDOF) and multi-degree-of-freedom (MDOF) systems. Equation of motion for SDOF systems would be developed for periodic, non-periodic and arbitrary excitations. The numerical methods to obtain the dynamic response and their limitations would be discussed. The concept of earthquake response spectrum and design spectrum will be explained and their utility in the seismic analysis and design of structures would be discussed.

Course Content:

Unit-I Basic Concepts of Seismology [6 hrs]

Introduction, plate tectonics, earthquake distribution and mechanism, seismicity, seismic waves, earthquake magnitude and intensity, seismic zoning, Static and Dynamic analysis.

Unit-II Single Degree of Freedom Systems [11 hrs]

Various types of dynamic loads, vibration of single degree of freedom system, Free and forced vibrations, types of damping, critical damping. Transmissibility, vibration measuring instruments, response spectrum. Response under time dependent Transient and Steady state forcing functions - Damping effects - Damping Vibrations system - response under general type of excitation - numerical methods- response spectrum.

Unit-III Multi-degrees of Freedom (MDOF)Systems [11 hrs]

Free vibration - Determination of Natural frequencies and mode shapes - Vanello Stodola and Matrix iteration methods - Energy Methods - Lagrange's equation - Simple applications Mode super position method.

Unit-IV Continuous systems [8 hrs]

Free and forced vibrations of beams - Approximate solutions - Rayleigh and Rayleigh - Ritz Methods - Vibrating of building frames - modal analysis.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

Text Books:

1. Structural Dynamics - Theory & Computations, Mario Paz, Springer publisher, 2018, 6th Edition.
2. Dynamics of Structures, Clough and Penzien, McGraw Hill Book Co., 2015, 5th Edition.
3. Dynamics of Structures (SI Units), A.K. Chopra, Pearson, 2019, 5th Edition.

Reference Books:

1. Mechanical Vibrations, R Venkatachalam, PHI learning, 2014, 1st Edition.
2. Introduction to Structural Dynamics, J N Biggs, McGraw Hill Book Co., 1964.
3. Dynamics of Structures, J. Humar, CBS Press, 2012, 3rd Edition.
4. Dynamics of Structures, Patrick Paultre, Wiley Publishers, 2011.
5. Dynamic Analysis of Structures, John T. Katsikadelis, Elsevier Academic Press, 2020

Course Outcomes: On completion of the course, the students shall be able to
CO1 Model and Formulate dynamic equilibrium equations for SDOF and MDOF systems.
CO2 Analyse SDOF and MDOF systems using classical and numerical methods.
CO3 Perform modal analysis and compute seismic response of Structural systems.
CO4 Analyze the effects modal parameters on dynamic response.

CEPE309 Introduction to Finite Element Method

Pre-requisite: Mathematical Methods, Structural Analysis

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This is an introductory level course on Finite Element Method. After attending the course, the students will be able to comprehend FEM as a numerical technique to solve partial differential equations representing various physical phenomena in structural engineering.

Course Content:

01. **Matrix Methods of Structural Analysis**: Review of concepts – Actions and displacements – compatibility – indeterminacy – Member and joint loads – Flexibility Matrix formulation – Stiffness Matrix formulation.
    Introduction to Finite Element Method: Background and general description of the method summary of the analysis procedure. **[06]**
02. **Theory of Finite Element method**: Discretization concept- Concept of element – various elements shapes – displacement models – Convergence- shape functions – condensation of internal degrees of freedom-Summary of analysis procedure. **[06]**
03. **Finite Element Analysis**: Development of shape functions for different elements-Spring- Truss- Beam-Plane elements- Plane stress and plane strain-Assemblage of elements construction of stiffness matrix and loads – boundary conditions –patch test-solution of overall problem. **[08]**
04. **Isoparametric Formulation**: Concept of Isoparametric element – One and Two dimensional elements-Natural coordinates- Development of Higher order elements-Lagrange – Serendipity –Interpolation-formulation of element stiffness and loads. **[08]**
05. **Application to Solid Mechanics problems**: Analysis of Trusses – Beams – Frames and 3D space elements. **[08]**

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Introduction to Finite elements in Engineering, Tirupathi Chandra Patla and Belugundu, Pearson, 2015, 4th Edition.
2. The Finite element Method in Engineering, S. S. Rao, Elsevier Publication, 2020, 6th Edition.
3. Finite Element Method: Its Basic and Fundamentals, O.C. Zeinkiewicz, Butterworth Heinemann, 2007, 6th Edition.
4. Textbook of Finite Element Analysis, P. Seshu, PHI Pub., 2003
5. Introduction To Finite Element Method, J. N. Reddy, McGraw Hill Pub., 2020, 4th Edition.
6. Fundamentals of finite element analysis, David Hutton, McGraw Hill Pub., 2017.
7. Numerical Methods in Finite Element Analysis, Bathe K J, Prentice-Hall civil engineering and engineering mechanics series, 2016.

8. Cook, R. D., Malkus, D. S. and Plesha M. E., 'Concept and Applications of Finite Element Analysis', John Wiley & Sons, New York.
9. Desai, C.S. and Abel J. F., 'Introduction to the Finite Element Method', Affiliated East-West Press Pvt. Ltd. N. Delhi.

Course Outcomes: On completion of the course, the students shall be able to:

CO1 Develop shape functions and stiffness matrices different finite elements
CO2 Develop global stiffness matrices and global load vectors
CO3 Apply natural and arial coordinate systems to constant strain triangle and linear strain
CO4 Analyze Structural Systems using finite element modeling

CEPE310 Rock Mechanics

Pre-requisite: Engineering Geology and Geotechnical Engineering

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This course will help students understand the problems associated with underground excavations. It will help students in classifying rocks for engineering purpose, to conduct laboratory and field testing to assess strength and deformational behaviour of rocks and understand associated rock failure criteria.

Course Content:

Unit-I (12 hrs)

Introduction: Importance of rock mechanics, composition of rocks, geological and lithological classification of rocks, classification of rocks for engineering purpose, R.Q.D. method of classification of rocks, theories of brittle failure.

Laboratory testing of rocks: Various methods of obtaining rock cores, methods of sample preparation, methods of removing end friction of the rock samples, uniaxial compressive strength of rock samples, tensile strength-direct and indirect methods, Brazilian test, shear box test, triaxial shear test, punch shear test.

Unit-II (10 hrs)

In-situ testing of rocks: Field direct shear test on rock blocks, field triaxial strength, use of flat jacks, chamber test, plate load test, cable jacking test.

Stress evaluation in field: Stress-relief technique (over coring), use of strain gauges, bore hole, deformation cell, photo-elastic stress meter, stress measurement with flat jack. hydraulics fracturing techniques.

Unit-III (8 hrs)

Stabilization of rocks: Rock bolting, principle of rock bolting, various types of rock bolts, application of rock bolting. field testing of rock bolts and cable anchors.

Elastic and dynamic properties of rocks: Stress-strain behaviour, dynamic properties, resonance method and ultra-sonic pulse method.

Unit-IV (6 hrs)

Pressure on roof of tunnels: Trap door experiment, Terzaghi's theory, Bieraumer, kommerel, Protodyakanov theory.

Stress around the tunnels: Basic design and principles of tunnels in rocks, design of pressure tunnels in rocks.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Rock Mechanics Vol. I, II, III, IV by Lama et al.
2. Fundamentals of Rock Mechanics by Jaeger and Cook
3. Rock Mechanics by Stagg & Zienkiewiez
4. Rock Mechanics and Design of Structures in Rocks by Obert & Duvell
5. Art of Tunneling by Schzy

Course Outcomes:

On completion of the course, the students shall be able to:

CO1	Classify rocks using the reference data.
CO2	Understand the failure criteria of rock.
CO3	Determine in-situ stresses from field test data.
CO4	Determine pressure on and stress around underground excavations.

CEPE311 Ground Improvement Engineering

Pre-requisite: Geotechnical Engineering

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course is designed to provide students with the knowledge of various ground improvement techniques and will enable them to understand the factors that control the choice of a particular ground improvement technique as per the field condition.

Course Content:

Unit-I (6 hrs)

Introduction: Need and objectives of ground improvement, classification of ground modification techniques - suitability and feasibility, emerging trends in ground improvement.

Dewatering: methods of dewatering - sumps and interceptor ditches - single, multi stage well points, vacuum well points, horizontal wells, foundation drains, blanket drains, criteria for selection of fill material around drains, electro-osmosis.

Unit-II (9 hrs)

Compaction: Principles of compaction, engineering behaviour of compacted clays, field compaction techniques - static vibratory, impact, earth moving machinery, compaction control, application to granular soils, cohesive soils, depth of improvement, environmental considerations, induced settlements, compaction using vibratory probes, vibro techniques, vibro equipment, vibro compaction and replacement process, vibro systems and liquefaction, soil improvement by thermal treatment, preloading techniques, surface compaction, introduction to bio technical stabilization.

Unit-III (12 hrs)

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.

Admixtures: 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.

Unit-IV (9 hrs)

Reinforced Earth: Basic mechanism, choice of soil and reinforcement, strength characteristics of reinforced earth, principles of design of reinforced earth wall.

Geosynthetics: Raw materials, durability and aging, manufacturing methods, geotextiles-testing and evaluation, geotextile as separators and as reinforcement, geotextile in filtration, drainage and erosion control, bearing capacity improvement by geotextiles.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Ground Improvement by Blackie Moseley
2. Grouting in engineering Practice by R Boweven
3. Soil Reinforcement with Geotextiles by R A Jewell
4. Engineering with Geosynthetics by Rao & Raju
5. Soil Improvement Technique and Their Evolution by W E Van Impe

Course Outcomes:

On completion of the course, the students shall be able to:

CO1 Understand the basic mechanics of the various ground improvement techniques and apply the appropriate ground improvement technique to a field situation.

CO2 Improve the properties of soils using mechanical methods.

CO3 Improve engineering behaviour of the soils by the use of grouts and admixtures.

CO4 Improve the characteristics of the soils by the use of geosynthetic inclusions.

CEPE312 Traffic Engineering and Road Safety

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: Traffic Engineering utilises principles of Engineering to ensure a secure and efficient movement of people and materials on several modes of transport and road networks. The objective of the course is to give insight about traffic characteristics, traffic control, regulation and management measures. Road traffic safety refers to the methods and measures used to prevent road users from being killed or seriously injured.

Course Content:

UNIT-I (8 hrs)

Organisational set up of traffic engineering department in India. Traffic characteristics. Max dimensions and weights of vehicles. Traffic growth. Traffic studies. Accident statistics, Accident study. Parking Issues. Road alignments and road geometrics affecting road safety. Land use planning and road safety.

UNIT-II (10 hrs)

Space and time headway. Fundamental diagram of traffic flow. Relationship between speed, volume and density. Level of service. PCU. Design service volume. Capacity of non-urban & urban roads. Road congestion and road safety. IRC recommendations. Traffic control devices. Signal & Intersection Designs. Road markings, Traffic control aids and street furniture. Traffic control devices and road safety.

UNIT-III (10 hrs)

Traffic regulations. Regulation of speed, vehicles and drivers. General traffic regulations. Motor vehicle act. Scope of traffic management. Traffic management measures: restrictions on turning movements, one way streets, tidal flow operations, exclusive bus lanes, traffic restraint, road pricing. Enforcement and education measures for road safety.

UNIT-IV (8 hrs)

Road safety audit, RSA team, RSA Report, Elements of RSA, Detrimental effects of traffic. Vehicular air pollution. Situation in India. Vehicular emission norms in India and abroad. Alternate fuels. Factors affecting fuel consumption. Arboriculture.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Traffic Engg. and Transportation Planning by L. R. Kadiyali, Khanna Publishers, Delhi, 2002.
2. Highway Engg by S. K. Khanna & C.E.G. Justo, Veeraragavan A., Nem Chand Bros., Roorkee, 2014
3. Traffic Engg. by Matson, T.M., Smith, W.S. and Hurd, F.W., McGraw- Hill Book Co., New York.

4. Traffic Flow Theory by Drew, D.R., McGraw- Hill Book Co., New York.
5. Trainers Road Safety Manual, NHA and Ministry of Shipping, Road Transport and Highways, Govt of India.

Course Outcomes:

On completion of the course, the students shall be able to:

1. Gain Engineering knowledge of the subject and apply it for the solution of problems related to road safety.
2. Design geometrics, signals and intersections, make investigations, use modern tools and develop solutions to traffic problems including safety of road users.
3. Understand the engineering solutions in societal and environmental context for sustainable development that takes care of pollution and environment.
4. Understand the norms of engineering practice and the need for life-long learning as per their exposure to relevant latest IS/IRC/MoRTH specifications.

CEPE313 Transportation Planning

Pre-requisite: Traffic Engineering

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: Transportation planning is the process of defining future policies, goals, investments, and spatial planning designs to prepare for future needs to move people and goods to destinations. As practiced today, it is a collaborative process that incorporates the input of many stakeholders including various government agencies, the public and private businesses. Transportation planners apply a multi-modal and/or comprehensive approach to analyzing the wide range of alternatives and impacts on the transportation system to influence beneficial outcomes.

Course Content:

Unit-I **10 hrs**

1. **Transport Planning Process**

Status of transportation in India. Objectives and scope of transport planning. Urban, regional and national transport planning. Transport planning process, various stages. Land use and traffic.

2. Transportation Survey

Definition of study area. Zoning. Types of surveys. O-D surveys. Inventories of existing transport facilities, land use and economic activities.

Unit-II **10 hrs**

3. Trip Generation

Trip purpose. Factors affecting trip generation. Trip generation estimation by multiple linear regression analysis, brief review of category analysis, advantages and limitations of these methods.

4. Trip Distribution

Methods of trip distribution. Basic concepts of uniform factor method, average factor method and opportunity model. Trip distribution by gravity model.

Unit-III **8 hrs**

5. Traffic Assignment

Principles of assignment. Assignment techniques. All or nothing assignment. Brief review of multipath assignment, capacity restraint assignment and diversion curves.

6. Modal Split

General considerations for modal split. Factors affecting modal split. Brief introduction to various methods of modal split.

Unit-IV **8 hrs**

7. Evaluation

Need for evaluation. Several plans to be formulated. Testing. Considerations in evaluation. Economic evaluation, basic principles, brief introduction to various methods of economic evaluation, comparison.

8. Mass Rapid Transit Systems

Problems of Urban Transport. Introduction to MRTS. Requirements of MRTS. Types of MRTS. MRTS in India. MRTS Corridor selection

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible

sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Traffic Engg. and Transport Planning by L. R. Kadiyali, Khanna Publishers, Delhi.
2. Highway Engg by S. K. Khanna & C.E.G. Justo, Nem Chand Bros., Roorkee.
3. Introduction to Transport Planning by Bruton, M.J., Hutchinson Technical Education, London.
4. Principles of Transportation Engg, P. Chakroborty & Animesh Dass, Prentice Hall of India, 2003.

Course Outcomes:

On completion of the course, the students shall be able to:

1. Gain Engineering knowledge of the subject and apply it for the solution of problems related to urbanisation
2. Make investigations, use modern tools, forecast travel demand and develop solutions to cater to increased future traffic.
3. Understand the engineering solutions in societal and environmental context for sustainable development that takes care of optimal use of resources.
4. Understand the norms of engineering practice and the need for life-long learning as per their exposure to relevant latest know-how in the field of planning.

CEPE314 Pollution Control and Waste management

Pre-requisite: Knowledge of basics of science and engineering.

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course:
The course is designed to provide students with the knowledge of environmental pollution and its control. The course covers a wide range of topics, including water pollution, air pollution, noise pollution, and solid waste management.

Course Content:

Unit-I **(10 lectures)**
Water Pollution
Sources, effects and control of water pollution. Characterization of waste water, composition of domestic and industrial waste water, decomposition of organic matter, self-purification of natural rivers/streams. Standards for discharge of effluents in waterbodies. Objectives of wastewater treatment, classification of treatment process. Flow scheme of conventional sewage treatment plant and functions of treatment units – preliminary, primary, secondary and tertiary treatment units.

Unit-II **(10 lectures)**
Air Pollution
Composition and structure of atmosphere, classification and sources of air pollutants, effects of air pollution on plants, animals, human health, economic effects of air pollution, greenhouse effect and global warming, ozone layer depletion and acid rains. Meteorological parameters influencing air pollution. Air quality standards and air quality index, automobile pollution - effects and control measures. Atmospheric self – cleansing processes, approaches and techniques of air pollution control. Air pollution control devices: Gravitational settling chamber, cyclones, wet scrubbers, fabric filters, ESP and catalytic converters.

Unit-III **(6 lectures)**
Noise Pollution
General introduction to noise pollution, human acoustics, unit of measurement, loudness, measurements of noise and weighting networks, sources and effects of noise pollution, noise abatement/control, noise standards.

Unit-IV **(10 lectures)**
Solid Waste Management
Definition, types, composition and sources of solid wastes, Solid Waste Management Rules (2016), storage and collection of municipal solid waste, methods of solid waste disposal – composting, incineration, pyrolysis and sanitary land filling, recovery of materials and energy from solid waste.
Water conservation, indoor air pollution control, composting and biogas plants, bioremediation and phytoremediation using indigenous techniques.

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Text Books/Reference:

1. Environmental Engineering by H. S. Peavy, D. R. Rowe and G. Tchobanoglous
2. A basic Course in Environmental Studies by S. Deswal and A. Deswal
3. Air Pollution by M. N. Rao
4. Environmental Noise Pollution by P. F. Cuniff
5. Solid Waste Management Collection, Processing and Disposal by A. D. Bhide and B. B. Sundaresan

Course Outcomes:

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

CO1: Understand the sources, characterization and treatment of waste water

CO2: Identify the types, sources, effects and control of air pollutants

CO3: Understand the sources and effects, and select appropriate measures for noise pollution control

CO4: Understand the various functional elements involved in solid waste management.

CEPE315 Environmental Impact Assessment

Pre-requisite: Knowledge of basics of science and engineering

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course:
The course is designed to provide students' knowledge related to environmental impacts of developmental projects, regulatory requirements, impact assessment tools and mitigation measures. The course covers a wide range of topics, including impacts of development projects, EIA tools and techniques, impact mitigation and environmental management plan.

Course Content:

Unit-I **(9 Lectures)**
Introduction
National environmental policy, impacts of development projects on environment, need of EIA, Environmental Impact Assessment (EIA) and Environmental Impact Statement (EIS) - Objectives - EIA Types, EIA in project cycle - Capacity and limitations, Legal provisions on EIA, Environmental Impact Assessment notification, Methods of categorization of industries for EIA, Elements of EIA Process - screening, scoping, baseline studies, impact prediction, assessment of alternatives, delineation of mitigation measure, EIA Report

Unit-II **(11 Lectures)**
EIA Methodology
Criteria for the selection of EIA methodology, Methods of EIA - matrices, checklist, Networks methods, Overlays methods - strength, weakness and applicability, Prediction and assessment of impact on land, water, air, noise and energy, flora and fauna, Socio economic impact, Mathematical models for impact prediction, rapid EIA, public participation

Unit-III **(9 Lectures)**
Environmental Management Plan
Post environmental audit, Plan for mitigation of adverse impact on environment – Options for mitigation of impact on water, air and land, energy, flora and fauna; addressing the issues related to the project affected people, Environment Management Plan – ISO 14000

Unit-IV
Case Studies **(7 Lectures)**
EIA case studies for new and expansion projects: township projects, river valley projects, thermal power plants and industrial plants. Indigenous and sustainable technologies/practices of environmental management and impact mitigations.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1 Environmental Impact Assessment by Canter, R. L.
2 Environmental Impact Assessment Methodologies, Anjaneyulu, Y. and Manickam. V., B.

3 Concepts in Environmental Impact Analysis by Shukla S. K. and Srivastava, P. R.
4 Environmental Impact Analysis by John G. Rao and David C. Wooten (Ed.).

Course Outcomes:

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

CO1: Identify environmental attributes and formulate objectives for EIA studies

CO2: Predict and assess the impact of proposed projects on the environment

CO3: Propose proper mitigation measures to avoid environmental impacts

CO4: Prepare EIA report with suitable environmental management plan

CEPE316 Ground Water Engineering

Pre-requisite: Basics of Soil Mechanics, Fluid Mechanics

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course is divided into four units, with Unit I covering aquifer properties, groundwater flow equations, exploration techniques, and determination of hydraulic properties. Unit II focuses on tube well design, construction, working, pumping equipment, and hydraulic testing. Unit III explores artificial recharge methods, Ghyben-Herzberg relation, and control of saltwater intrusion. Finally, Unit IV/V addresses urban water demand management, rainwater harvesting, groundwater modelling, and integrated water resources management and governance.

Course Content:

Unit-I (9 hrs)

Properties of Aquifers, Formation constants, compressibility of aquifers, Equation of motion for steady and unsteady ground water flow in isotropic homogeneous aquifers, Dupit's assumptions. Unconfined flow with a recharge, tiled train problem. Ground water exploration and methods of investigations. Effect of boundaries, interference of water, leaky aquifers, Thiem's equilibrium formula for unconfined and confined aquifers and determination of hydraulic properties of aquifers. Non equilibrium formula for aquifer (unsteady radial flows).

Unit-II (7 hrs)

Tube wells, optimum capacity, silting of tube well, design of tube wells in different aquifers, tube well types, parts, bore hole, strains, its types, well pipe, casing pipe, blind pipe. Construction and working of tube wells, site selection, drilling operation, cable tool method, hydraulic method, Rotary Method and drilling fluids, well screen assembly installation, verticality and alignment of tube wells, gravel packing, development of tube wells, sickness, corrosion and failure of tube wells, Pumping equipment and hydraulic testing of pumps.

Unit-III (11 hrs)

Artificial recharge of ground water, considerations and methods, recharge techniques induced infiltration, water spreading, flooding, basins, ditching, modification of natural channels, irrigation, recharge pits, shafts and recharge wells

Ghyben-Herzberg Relation between fresh and saline water shape and structure of fresh water and salt water interface, upcoming saline water, fresh water and salt water relations on oceanic islands Occurrence of saline water intrusion, Control of salt water intrusion, Recognition of sea water in the ground water.

Unit-IV (9 hrs)

Urban Water Demand Management: Investigate and develop sustainable strategies for managing water demand in urban areas, including efficient water use practices, conservation measures, and public awareness campaigns.

Rainwater Harvesting and Storm Water Management: Study the implementation of rainwater harvesting systems and sustainable storm water management techniques to recharge groundwater and reduce runoff in urban environments.

Groundwater Modelling and Simulation: Develop numerical models and simulation tools to assess the impact of urbanization on groundwater resources, evaluate different management scenarios, and optimize sustainable groundwater allocation strategies.

Integrated Water Resources Management & Policy and Governance

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Ground water Hydrology, D. K. Todd, John Wiley & Sons Inc. New York.
2. Groundwater, H.M. Raghunath, Wiley Eastern Ltd., N. Delhi
3. Karamouz, M, Ahmadi, A, and Akhbari, M, Groundwater Hydrology: Engineering, Planning and Management, CRC Press
4. Ground Water Hydrology, V.C. Aggarwal, PHI Learning Private Limited New Delhi
5. Davis, S.N., and De Weist, R.J.M., Hydrogeology, John Wiley & Sons, New York
6. Domenico, Concepts and Models in Groundwater Hydrology, McGraw Hill Inc. New York.

Course Outcomes:

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

CO1: Course imparts aquifer knowledge, flow equations, exploration, and data analysis for informed groundwater resource management.

CO2: Study consist of a comprehensive knowledge guides tube well design, construction, operation, and maintenance, improving efficiency, longevity, and performance.

CO3: Study outcomes on artificial groundwater recharge, Ghyben-Herzberg relation, and saltwater intrusion improve groundwater management, freshwater-saltwater dynamics understanding, and sustainable water resource management strategies.

CO4: Learning outcomes contribute to sustainable water management, urban water systems understanding, and policies promoting efficient water use and integrated water resources management.

CEPE317 Flood Control & Drainage Engineering

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Pre-requisite: None

Brief description of the course: Students will be able to understand measurement techniques of various hydrologic data required for water resources projects

Course Content:

Unit-I (9 hrs)

1. Introduction:
   Indian rivers, flood, flood problems, river morphology, behaviour of river flow, role of sediments in rivers, changes in regimes, river gauging, causes of flood and losses, alleviation of flooding.
2. Flood Mitigation by River Protection:
   Basis of river engineering, flow types, resistance flow, energy slope, backwater effect, three-dimensional flow, circular and helicoidal flow, river improvement works, river survey, protection by embankment, discharge capacity, design of dyke, stability analysis of dykes, bank protection, bank recession, types of bank protection works, channel improvement, cutoffs diversion, bypass channel, cutoff channel, flood ways, flood plain zeroing, spreading grounds.

Unit-II (7 hrs)

3. Flood Mitigation by Reservoirs:
   Design factors, storage capacity determinations, sequent peak algorithm method, live storage, ripple mass curve flood routing, flood storage, dead storage, reservoir classification, reservoir sedimentation, distribution of sediments in reservoirs, measurement of sediment yields, sediment load measurement, Mood's method, life of reservoir, reservoir operation based on annual storage and regulation, single and multi-purpose reservoirs, gate operation schedule, maximum and minimum flow operation, multi-purpose reservoir operation, reservoir economics-cost benefit ratios, optimization of benefits.

Unit-III (11 hrs)

4. Flood Forecasting & Warning:
   Basic data, communication network, forecasting techniques and procedures, forecast of rainfall, runoff from rainfall, forecasting stages, peak travel time, forecast reporting flood warning, engineering methods for flood fighting
5. Engineering Economics of Flood Control:
   Estimation of flood damages, estimation of benefits of flood control, cost benefit analysis of flood control project.

Unit-IV (9 hrs)

6. Design of Subsurface Drainage System
   Introduction, necessity for drainage, removal of drainage water, design of closed underdrains, design of open underdrains. Design for leaching requirements.
7. Design of surface drainage systems
   Necessity of surface drainage, surface drainage channels design considerations, general design consideration of outfall culvert, design consideration of tidal channels and outfall sluices

8. Application of remote sensing technology for flood control
   Introduction, application for planning flood control measures, flood warnings
9. Disaster Management concepts and approaches
   Introduction, man-made disaster, Disaster management in India

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Flood Control & Drainage Engineering by S. N. Ghosh
2. Hydrology & Flood Control Engg. by S. K. Garg
3. Hydrology & Water Resources Engg. by K. C. Patra
4. Disaster Management, Concepts and Approaches by D. Mondal & D. Basu
5. Elementary Hydrology by V. P. Singh

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: know causes of flood and its problems
CO2: be familiar with flood mitigation techniques by river protection & reservoirs
CO3: know concept of flood forecasting techniques.
CO4: be acquainted with the surface and sub-surface drainage systems.

CEPE318 Health Monitoring of Structures

Pre-requisite: Knowledge of Concrete Structures, Steel Structures, Physics of Sensors

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: Introduction, Structural Health Monitoring (SHM), Sensors, Data Management, Prediction of Remaining Service Life, Repair, Rehabilitation and Retrofitting of Distressed Structures.

Course content:

Unit-I: 09 (L)
Introduction: Qualitative and non-continuous methods of evaluation of structures,
Structural health monitoring (SHM): Definition, Detecting the existence of the damage on the structure, Locating the damage, Identifying the types of damage, Quantifying the severity of the damage.

Unit-II: 07 (L)
Sensors: Feature extraction through signal processing and statistical classification, Structure Data acquisition systems, Data transfer and storage mechanism.

Unit-III: 11(L)
Data management, Data interpretation and diagnosis, System Identification, Structural model update, Structural condition assessment.

Unit-IV: 09 (L)
Prediction of remaining service life, Different sensors, accelerometers, strain gauges, displacement transducers, level sensing stations, anemometers, temperature sensors and dynamic weight-in-motion sensors, Case studies, SHM for buildings and bridges, etc., Repair, rehabilitation and retrofitting of distressed concrete and steel structures.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Raghavan, A. and Cesnik, C. E., Review of guided-wave structural health monitoring," Shock and Vibration Digest, vol. 39, no. 2, pp. 91-114, 2007.
2. Shen-En Chen, R. Janardhanam, C. Natarajan, Ryan Schmidt, Indo-U.S. Forensic Practices - Investigation Techniques and Technology, ASCE, U.S.A., 2010.
3. Natarajan C., R. Janardhanam, Shen-En Chen, Ryan Schmidt, Indo-U.S. Forensic Practices - Investigation Techniques and Technology, NIT, Tiruchirappalli, 2010.
4. Gary L. Lewis, Guidelines for Forensic Engineering Practice, ASCE, U.S.A., 2003.
5. Joshua B.Kardon, Guidelines for Forensic Engineering Practice, ASCE, U.S.A., 2012.

Course Outcomes:
Upon successful completion of the course, the students will be able to
CO1: Perform Structural health monitoring of different types of structures

CO2: Handle emerging technologies using sensors
CO3: Perform notable applications of structural health monitoring in Civil applications.
CO4: Repair, rehabilitate and retrofit distressed concrete and steel structures.

CEPE319 Experimental Stress Analysis

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Pre-requisite: Mechanics of Solids
Brief description of the course: The course covers the fundamental aspects of experimental stress analysis that includes most versatile techniques like strain gauges and a brief introduction to the load, pressure and displacement transducers. In addition, it also provides the fundamental of photo elastic coatings, different experimental techniques such as Moire fringe and brittle coating techniques.

Course Content:

Unit-I (9 hrs)
Strain gauges – Mechanical, optical, acoustic, electrical inductance and capacitance pneumatic types – description and working principles Electrical resistance strain gauges, gauge characteristics and types – Equipment for recording static strain – reduction of strain gauge data.

Unit-II (10 hrs)
Load, pressure and displacement transducers. Model analysis – direct and indirect models – law of structural similitude – choice of scales – Model materials – limitations of model studies –Buckingham PI theorem – design of direct and indirect models – Beggs deformeter and its applications.

Unit-III (8 hrs)
Two-dimensional photo – elasticity – optical principles stress optic law – Methods of producing isoclines and isochromatics using polariscopes – Methods of measuring fractional fringe orders – model materials – separation techniques

Unit-IV (7 hrs)

Fundamental of Photo elastic coatings, Moire fringe and brittle coating techniques – Introduction to stress freezing techniques – Introduction to non-destructive testings.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Daley and Riley, Experimental Stress Analysis, McGraw Hill Book Company, 1987
2. Srinath, L.S. et al., Experimental Stress Analysis, Tata McGraw Hill 1984.
3. Hetenyi, M., Hand Book of Experimental Stress Analysis, John Wiley & Sons. Inc New York. 1980.

Course Outcomes:
On completion of the course, the students will be able to:
1. identify the different types of strain gauges
2. carry out model analysis

3. apply the concepts of photo elastic coatings
4. analyze the behaviour of 2-D photo elasticity
5. apply the working principles of transducers

CEPE320 Construction Techniques and Equipments

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Pre-requisite: Building Construction and Materials

Brief description of the course: This course introduces students to the basic construction principals and building components used in construction technology. It offers the basic understanding of the Prefabricated structures and building services. Further, a deep insight into repair and rehabilitation technique. In addition, this course provides comprehensive information on guidelines for selection of equipment used in construction technology.

Course Content:

Unit-I (12 hrs)

Principles of construction: Bonding, Reinforced brick work, Stone masonry, Hollow block masonry Composite masonry, Cavity walls, Flooring, Formwork, Centering and Shuttering sheet piles, Slip and moving forms, Roofs and roof covering, Joints in Concrete, Plastering and Pointing, Shoring and Scaffolding, underpinning, Submerge Structures.

Unit-II (9 hrs)

Prefabricated structures and building services: Prefabricated panels & structures, Production, Transportation and Erection of structures, Sound insulations, Ventilations, Fire resisting construction, Damp proofing, Termite proofing.

Unit-III (7 hrs)

Construction damages & repair techniques: Causes of damage and deterioration in masonry and concrete structures, Symptoms & Diagnosis, Types of repair and rehabilitation techniques.

Unit-IV (9 hrs)

Basics of construction equipment: Factors affecting the selection of equipment, economic life of equipment, cost of equipment, maintenance of equipment. Construction equipment and machinery: Earthwork equipment, Hoisting and lifting equipment, Material handling equipment, Concrete equipment, dewatering equipment.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Arora, S.P. and Bindra, S.P. A Text Book of Building Construction, Dhanpat Rai Publications, New Delhi, 2005.
2. Varghese, P.C., Building Constructions, Prentice Hall, 2007.
3. Sharma & Kaul, Building Construction, S. Chand & Company Pvt, New Delhi, 1998
4. Peurifoy, R.L., Schexnayder, J.C., and Shapira, A, Construction Planning, Equipment and Methods, Tata McGraw Hill, New Delhi, 2010.
5. Sharma S.C. Construction Equipment and Management, Khanna Publishers, New Delhi, 2013.

Course Outcomes:

On completion of the course, the students will be able to:

1. Supervise and execute all the construction jobs with the knowledge of the different construction techniques

2. Identify the building defects and apply suitable repair techniques to rectify them
3. Evaluate the costs of equipment and make proper selection of the suitable construction equipment
4. Ensure the proper completion of a construction task using particular construction equipment

CEPE321 Steel Concrete Composite Structures

Pre-requisite: Knowledge of Design of Steel Structures, Design of Concrete Structures

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This course will cover fundamental concepts and applications of steel-concrete composites in the design of steel buildings and bridges with emphasis on composite beams and floor systems, composite columns, and composite walls. At the end of the course, the student will have an in-depth knowledge of relevant limit states / failure mode in steel components and structures, and a familiarity with the applicable topics in the IS and AASHTO Specifications and their basis in research / testing. The students will have some experience in solving design examples and looking at applications of the fundamental concepts learned in the course.

Course Content:

01. Introduction to steel - concrete composite construction – Composite action – Serviceability and - Construction issues. **[06]**

02. DESIGN OF CONNECTIONS: Shear connectors – Types – Design of connections in composite structures – Degree of shear connection – Partial shear interaction **[06]**

03. DESIGN OF COMPOSITE MEMBERS: Design of composite beams, slabs, columns, beam – columns - design of composite trusses. **[10]**

04. COMPOSITE BOX GIRDER BRIDGES: Introduction - behaviour of box girder bridges - design concepts. **[08]**

05. CASE STUDIES: Case studies on steel - concrete composite construction in buildings - seismic behaviour of composite structures. **[06]**

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Johnson R.P., "Composite Structures of Steel and Concrete"' Volume-I, Black Well Scientific Publication, U.K., 1994
2. Teaching Resources for "Structural Steel Design". Vol.2 of 3, Institute of Steel Development and Growth (INSDAG), 2000
3. Narayanan R., "Composite Steel Structures – Advances, Design and construction, Elsevier, Applied Science, U.K., 1987
4. Owens, G.W & Knowels, P., Steel Designers Manual," (fifth edition), Steel Concrete Institute (U.K), Oxford Blackwell Scientific Publication, 1992.
5. IS 11384 – 1985 Indian Standard Code of Practice for Composite Construction in

Course Outcomes: On completion of the course, the students shall be able to:

CO1 Analyze composite beams, columns, trusses, and box-girder bridges including the related connections.

CO2 Design different composite civil structural components

CO3 Solve practical problems related to composite structure

CO4 Make a decision based on case studies related to steel-concrete constructions of buildings

CEPE322 Earthquake Resistant Design of Buildings

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course has been designed to provide basics of earthquakes and response of structures to ground motion during earthquakes. The students will be able to design RCC buildings so as to sustain earthquake forces without collapse. The various provisions of Indian Standards relating to earthquake resistant design and construction of buildings will be explained in detail.

Course Content:

Unit 1. Composition of Earth, origin of earthquakes, Elastic rebound theory, Continental drift theory, seismic waves, magnitude and Intensity of Earthquakes, Tectonic features of India, Major earthquakes in India, Response spectrum, Design response spectrum. (6 lectures)

Unit 2. Dynamic analysis of single and multi-degree systems, Response of undamped single degree and multiple degree systems, Response of structures to ground motion, Free vibrations of MDF systems. (7 lectures)

Unit 3. Structural Systems for Lateral Seismic force, Mathematical modelling of multi-storeyed buildings as per Indian Standard on earthquake resistant design of structures, Seismic force for Design of buildings as per IS 1893-part1-2002. (8 lectures)

Unit 4. Design and ductile detailing of RCC buildings as per IS 13920-2016, Ductile detailing of Flexural members, Longitudinal reinforcement and transverse reinforcement, Design shear forces in columns, Beam column joints of Frames. (9 lectures)

Unit 5. Special shear walls, Design for shear force, axial force and bending moments, Performance of SMRF and shear wall buildings during recent earthquakes, Repair and retrofitting of buildings. (6 lectures)

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice- Hall of India, New Delhi, 2003.
2. www.nicee.org, nicee@iitk.ac.in

Course outcomes:

On completion of the course, the students will be able to:

1. Understand basics of Earthquake Engineering
2. Design Earthquake resistant RCC structures.
3. Guide construction of different types of structures.
4. Apply skills in field for suitable lateral systems.

CEPE323 Application of Artificial Intelligence in Civil Engineering

Pre-requisite: Knowledge of basics of Civil Engineering

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course covers the application of various artificial techniques used for modeling of data sets to the various civil engineering problems.

Course Content:

Unit-I (9 hrs)
Introduction to Artificial Neural Network: Feed-forward and Feed-Backward -work. Neural network learning rules. Linear separability of training patterns, Perceptron learning Algorithms. Multilayer Networks: Exact and approximate representation using feed forward net-works, Fixed Multilayer feed forward Network Training by Back propagation

Unit-II (7 hrs)
Recurrent Network: Symmetric networks and Associative Memory, Bi-directional Associative Memory. Analog Hopfield networks, simulated Annealing in optimization. Case studies for modeling using ANN and Fuzzy.

Unit-III (10 hrs)
Introduction to Fuzzy logic: Statistics and random Processes, Uncertainty in information. Classical Sets and Fuzzy Sets: Classical sets, operations on classical sets, properties of classical sets. Mapping of classical sets to functions, Fuzzy sets, fuzzy set operations, properties of Fuzzy sets

Unit-IV (10 hrs)
Classical Relations and Fuzzy Relations: Cartesian product, crisp, relations, cardinality of crisp relations, operations on crisp relation, properties of crisp relations. Composition, fuzzy relations. Cardinality of Fuzzy relations, operations on Fuzzy relations. Properties of Fuzzy relations. Membership Functions: Fuzzification, Membership value assignment. Fuzzy-to-crisp Conversions: Defuzzification Methods

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:
1. Zurada, J. M. Introduction to artificial neural Network System. Jaico Publishing House.
2. Haykin, S.ANN a comprehensive Foundation. Macmillan College Publishing Company, New York.
3. Bose, N.K. and Liang, P. Neural network Fundamentals with Graphs Algorithms, and Applications. Tata McGraw Hill.
4. Ross, J. Timothy. " Fuzzy logic with Engineering Applications". McGraw Hill.
5. Asai, K. Fuzzy systems for information processing". IOS press.

Course Outcomes:

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

CO1: Incorporate skills in developing models for various systems

CO2: Develop neural network and fuzzy logic model

CO3: Provides basic knowledge on fuzzy system and optimization tools

CO4: Apply modeling tools to civil engineering problems

CEPE324 Bridge Engineering

Pre-requisite: Knowledge of Transportation Engineering, Concrete Structures, Steel Structures, Prestressed Concrete and Geotechnical Engineering

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief Description about the course: Introduction to Briges, Standard Specifications for Roads and Railways Bridges, Design Consideration for RC and Steel Bridges, Hydraulic and Structural Design of Sub-structures, Brief Description of Bearings, Joints and Foundation, Sustainable Material, Retrofitting of Distressed Bridges.

Course Content:

Unit-I: 09 (L)
Introduction to Bridges
Definition, components of bridge, classification of bridges, selection of site, economical span, essential hydraulic and structural design data**.**
Standard Specifications for Roads and Railways Bridges
General considerations, Indian Road Congress Bridge Code, width of carriage way, clearance, various loads to be considered for the design of roads and railway bridges, detailed explanation of IRC standard live loads.

Unit-II: 07 (L)
Design Consideration for R. C. Bridges
Various types of RC bridges, brief description of different types of bridges, design of RC culvert, T-beam bridges, PSC bridges, design examples.

Unit-III: 11 (L)
Design Consideration for Steel Bridges
Types of steel bridges, brief description of various types of steel bridges, design of trussed and plate girder bridges, composite bridges, design examples.

Unit-IV: 04 (L)
Hydraulic and Structural Design of Substructures
Various types of piers, abutments, wingwall and approaches, hydraulic and structural design considerations, design examples.

Unit-V: 05 (L)
Brief Description of Bearings, Joints, Foundations, Sustainable Material and Retrofitting of Distressed Bridges
Types of bearings, joints and articulations, various types of foundations, necessary investigations, design criteria, design examples.
Case studies on failures of bridges, sustainable materials for bridge construction, rehabilitation and retrofitting of distressed bridges.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Essentials of Bridge Engineering, D. J. Victor, Oxford & IBH Pub., N. Delhi.
2. Design of Bridges, N. Krishna Raju, Oxford & IBH, N. Delhi.
3. Bridge Deck Analysis, R. P. Pama & A. R. Cusens, John Wiley & Sons.
4. Design of Bridge Structures, T. R. Jagadish & M. A. Jairam, Prentice Hall of India, N. Delhi.

Course Outcomes:

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

CO1: Design the RC slab culvert, Box culvert
CO2: Design the T- beam bridge, PSC bridges, and substructures
CO3: Design the bridge bearings
CO4: Design the steel bridge for railways
CO5: Implement sustainable materials for bridge construction, rehabilitation and retrofitting techniques on distressed bridges

CEPE325 Soil Dynamics

Pre-requisite: Geotechnical Engineering

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course has been designed to help students understand the principles of design in soil mass subjected to dynamic forces and its application for the design of earth retaining structures and foundations of industrial machines, and also to understand the concept liquefaction and methods of vibration isolation.

Course content:

Unit-I (12 hrs)

Theory of vibrations: Nature of dynamic loads, characteristic elements of a vibrating system, properties of harmonic motion, analysis of single degree freedom system with undamped free vibration, damped free vibration, undamped forced vibration and damped forced vibration, logarithmic decrement, frequency dependent excitation force, determination of viscous damping, principle of vibration measuring instruments, transmissibility, active isolation, passive isolation, methods of active and passive isolation.

Unit-II (12 hrs)

Machine foundations: Types of machines and machine foundations, criteria for satisfactory action of a machine foundation, degrees of freedom of a block foundation, Barkan's soil spring constants and their determination, analysis of vibrations of block foundation by Barkan's theory of linear elastic weightless spring analogy, Indian Standard for design and construction of foundations for reciprocating machines, foundation for impact machines, Indian Standard for design and construction for impact machines, design examples.

Unit-III (6 hrs)

Dynamic earth pressure problems: Modification of Coulomb's theory and Culmann's construction for dynamic loads, analytical solutions for c-ϕ soils, point of application, Indian Standard Code of Practice.

Unit-IV (6 hrs)

Liquefaction of soils: Theory of liquefaction, criteria of liquefaction, factors affecting liquefaction characteristics, evaluation of liquefaction potential of a soil deposit, liquefaction analysis from SPT data, anti-liquefaction measures.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1 Dynamics of bases and foundations by D D Barkan.
2 Soil dynamics by Shamsher Prakash.
3 Soil dynamics and machine foundations by Swami Saran.
4 Analysis and design of foundations for machines by Shamsher Prakash and V K Puri.
5 Handbook of machine foundations by Srinivasalu & Vaidyanathan.
6 Principles of soil dynamics by Braja M Das.
7 Vibration and Shock Isolation by Crede.

Course Outcomes:

On completion of the course, the students shall be able to

1. Understand basics of dynamics and dynamic behaviour of soil.
2. Propose vibration and shock isolation systems for various projects.
3. Evaluate and select parameters, and design foundations for industrial machines.
4. Determine earth pressure on retaining walls taking into consideration the seismic effects.
5. Understand the theory of liquefaction and evaluate liquefaction potential.

CEPE326 Water Distribution Systems

Pre-requisite: Water Supply Engineering and Fluid Mechanics

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief Description about the course: Water Distribution Systems is one of the Key components of water supply systems. This course deals with the complex hydraulics involved in the systems as well as is also helpful in the analysis and design of various components of water distribution systems like reservoirs, pumps and pumping mains and layout designing etc. It also deals with the advance methods of analysis used in the current practices. It further focuses on tools and techniques currently used for the designing.

Course Content:

Unit - I **(8 hrs.)**

General Hydraulic Principles, Head loss formulae- Darcy-Weisbach formula, Hazen – Williams formula, Modified Hazen-Williams formula, Series and Parallel connection of Pipes, Equivalent Pipes, Analysis of branched Water Distribution Networks.

Formulation of Equations for looped Water Distribution Networks, Analysis of flow in looped networks using Hardy Cross, Newton-Raphson and Linear Theory method, Introduction of Gradient method and other methods of analysis.

Unit - II **(9 hrs.)**

Reservoirs, Pumps and Valves (check valve, flow control valve and pressure reduces valve) in Water distribution systems. Flow dependent analysis of multi-reservoir systems, Introduction to head-dependent analysis.

Node flow analysis (NFA) of water distribution networks: Node head–flow relationships, Direct and Indirect methods, Application of NFA technique to serial networks.

Unit - III **(9 hrs.)**

Optimal and Economical diameter of pumping main, Design of pumping main considering diameter as continuous as well as discrete variable. Water hammer consideration.

Design of water distribution networks using Critical Path Method, Formulation of optimization model, Application of Cost-head loss ratio method and Linear Programming Technique to optimal design of branched networks.

Unit - IV **(10 hrs.)**

Determining number of branching configuration for a looped network, Use of path concept and minimum spanning tree concept, Application of critical path method for design of looped networks. Introduction to methods for Looped WDNs.

Case studies on Water Distribution Systems Design - Pumps and Pumping mains designs, Pipe network designs, Case study on conversion from intermittent to continuous supply etc.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Bhave P.R. and Gupta R.(2006), Analysis of water distribution Networks, Narosa Publishing Co, New Delhi (Also from UK)
2. Bhave P.R. (2003), Optimal Design of Water Distribution Networks Narosa Publishing Co, New Delhi.
3. Jeppson R W. (1976), Analysis of flow in pipe networks, Ann Arbon Science AunArbox Michigan USA.
4. Walksi T-M. (1984), Analysis of water distribution System Van Nostand Reinheld G, New York USA.
5. CPHEEO (1999), Manual on Water Supply and Treatment, Ministry of Urban Development G01.

Course Outcomes:

On completion of the course, the student should be able to:

CO1: Understand various components (pumps, pumping main, gravity main, ESR, and network) of water distribution systems to meet desired needs.

CO2: Analyze the water distribution systems considering traditional and advanced analysis methods.

CO3: Design existing as well as new water distribution networks.

CO4: Apply the knowledge about optimization of water distribution model in various applications.

CEPE327 Geoinformatics and Natural Hazards

Pre-requisite: Basic of Geoinformatics

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course:
This course will help students to understand different type of natural and manmade hazards and the application of remote sensing, GPS and GIS for natural hazard studies. To identify possibilities of future hazards using various Geoinformatics approaches.

Course Content:

Unit 1 (6L)
Introduction: Types of hazards and disasters, characterization, zonation of hazards, natural and human induced disasters. Basic of remote sensing/GIS

Unit 2 (6L)
Concept of Disaster Management: Fundamental concept of Disaster Management, National disaster management framework; role of NGOs, community–based organizations and media. Geoinformatics in disaster mitigation. Application of emerging Technologies for different disasters.

Unit 3 (16L)
Geological Hazards: Landslide, Earthquake, Mining hazards (subsidence, flooding etc.), volcanic hazards, Groundwater hazards, glacial hazards, Hydro meteorological Hazards: Flash floods, River floods, Cyclones, Coastal hazards and Droughts.
Environmental hazards: Forest hazards (Deforestation, Degradation and Forest fire), Land and soil degradation, desertification and Pollution (Water, air and soil), Geoinformatics Applications: Geoinformatics applications in managing various type of hazards including forest fires, floods, landslides, cyclone and earthquake, multiple hazard mapping.

Unit 4 (8L)
Case Studies of Landslides, Floods, Drought, Environmental hazards etc using geoinformatics techniques.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Jay Gao, Remote Sensing of Natural Hazards, 2022, CRC Press.
2. Brian Tomaszewski, Geographic Information Systems (GIS) for Disaster Management, 2020, Taylor & Francis.
3. T.S. Chouhan, Space Technology and GIS for Disaster Monitoring and Mitigation, 2018. Scientific Publishers
4. Pravat Kumar Shit, Pulakesh Das, Hamid Reza Pourghasemi, Gouri Sankar Bhunia, Adimalla Narsimha. Geospatial Technology for Environmental Hazards Modeling and Management in Asian Countries (Edited) 2021. Springer International Publishing.
5. Edward A. Keller, Duane E. DeVecchio, Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes, 2016, Taylor & Francis
6. K. Palanivel, J. Saravanavel, S. Gunasekaran, Disaster Management, 2015, Allied Publishers.

Course outcomes:

On completion of the course, the student should be able to:

CO1: Understand various types of disasters and the factors influencing them.

CO2: Identify various stages of disaster management and planning using Geoinformatics tools.

CO3: Apply geoinformatics in various stage of disaster management and disaster risk Reduction.

Open Electives (OE)

B.Tech. 5th Semester

CEOE301 Ground Improvement Engineering

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course is designed to provide students with the knowledge of various ground improvement techniques and will enable them to understand the factors that control the choice of a particular ground improvement technique as per the field condition.

Course Content:

Unit-I (6 hrs)

Introduction: Need and objectives of ground improvement, classification of ground modification techniques - suitability and feasibility, emerging trends in ground improvement.

Dewatering: methods of dewatering - sumps and interceptor ditches - single, multi stage well points, vacuum well points, horizontal wells, foundation drains, blanket drains, criteria for selection of fill material around drains, electro-osmosis.

Unit-II (9 hrs)

Compaction: Principles of compaction, engineering behaviour of compacted clays, field compaction techniques - static vibratory, impact, earth moving machinery, compaction control, application to granular soils, cohesive soils, depth of improvement, environmental considerations, induced settlements, compaction using vibratory probes, vibro techniques, vibro equipment, vibro compaction and replacement process, vibro systems and liquefaction, soil improvement by thermal treatment, preloading techniques, surface compaction, introduction to bio technical stabilization.

Unit-III (12 hrs)

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.

Admixtures: 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.

Unit-IV (9 hrs)

Reinforced Earth: Basic mechanism, choice of soil and reinforcement, strength characteristics of reinforced earth, principles of design of reinforced earth wall.

Geosynthetics: Raw materials, durability and aging, manufacturing methods, geotextiles-testing and evaluation, geotextile as separators and as reinforcement, geotextile in filtration, drainage and erosion control, bearing capacity improvement by geotextiles.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible

sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Ground Improvement by Blackie Moseley
2. Grouting in engineering Practice by R Boweven
3. Soil Reinforcement with Geotextiles by R A Jewell
4. Engineering with Geosynthetics by Rao & Raju
5. Soil Improvement Technique and Their Evolution by W E Van Impe

Course Outcomes:

On completion of the course, the students shall be able to:

CO1 Understand the basic mechanics of the various ground improvement techniques and apply the appropriate ground improvement technique to a field situation.

CO2 Improve the properties of soils using mechanical methods.

CO3 Improve engineering behaviour of the soils by the use of grouts and admixtures.

CO4 Improve the characteristics of the soils by the use of geosynthetic inclusions.

CEOE302 Geo-environmental Engineering

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course has been designed to expose the students to geo-environmental issues linking them with the community as well as well as industry, and to enable students to handle the geo-environmental problem in actual practice.

Course Content:

Unit-I (7 hrs)

Introduction: Introduction to Geo-environmental engineering, environmental cycle, sources, production and classification of waste, causes of soil pollution, factors governing soil-pollutant interaction, Safe disposal of waste.

Unit-II (7)

Contaminant Transport: Contaminant transport in sub surface, advection, diffusion, dispersion, governing equations, contaminant transformation, sorption, biodegradation and ion exchange.

Unit-III (10)

Landfill design and considerations: Precipitation, hydrological consideration in land fill design, site selection for landfills, characterization of land fill sites, waste characterization, stability of landfills, current practice of waste disposal, passive containment system.

Unit-IV (12)

Geosynthetics in environmental geotechnics: Application of geo synthetics in solid waste management, rigid or flexible liners, bearing capacity of compacted fills, foundation for waste fill ground.

Ground water pollution: Ground water pollution, pollution of aquifers by mixing of liquid waste, protecting aquifers.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Waste disposal in engineered landfills by Manoj Dutta, Narosa Publishing House.
2. Geosynthetics and Their Applications by S. K. Shukla and J.H Yin, CRC Press.
3. Solid Waste Management: Principles and Practice by Ramesha Chandrappa & Diganta Bhusan Das, Springer.
4. Geotechnical Engineering by Shashi K Gulati and Manoj Datta, Tata McGraw-Hill publishing.

Course Outcomes:

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

CO1: Understand the geoenvironmental issues at global, regional, and local levels.

CO2: Identify the sources of waste and options available for waste management.

CO3: Learn the design of landfills.

CO4: Understand the role of geosynthetics and natural Geotextiles in geoenvironmental engineering.

CEOE303 Flood Control & Drainage Engineering

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Pre-requisite: None

Brief description of the course: Students will be able to understand measurement techniques of various hydrologic data required for water resources projects.

Course Content:

Unit-I (9 hrs)

1. Introduction:
   Indian rivers, flood, flood problems, river morphology, behaviour of river flow, role of sediments in rivers, changes in regimes, river gauging, causes of flood and losses, alleviation of flooding.
2. Flood Mitigation by River Protection:
   Basis of river engineering, flow types, resistance flow, energy slope, backwater effect, three-dimensional flow, circular and helicoidal flow, river improvement works, river survey, protection by embankment, discharge capacity, design of dyke, stability analysis of dykes, bank protection, bank recession, types of bank protection works, channel improvement, cutoffs diversion, bypass channel, cutoff channel, flood ways, flood plain zeroing, spreading grounds.

Unit-II (7 hrs)

3. Flood Mitigation by Reservoirs:
   Design factors, storage capacity determinations, sequent peak algorithm method, live storage, ripple mass curve flood routing, flood storage, dead storage, reservoir classification, reservoir sedimentation, distribution of sediments in reservoirs, measurement of sediment yields, sediment load measurement, Mood's method, life of reservoir, reservoir operation based on annual storage and regulation, single and multi-purpose reservoirs, gate operation schedule, maximum and minimum flow operation, multi-purpose reservoir operation, reservoir economics-cost benefit ratios, optimization of benefits.

Unit-III (11 hrs)

4. Flood Forecasting & Warning:
   Basic data, communication network, forecasting techniques and procedures, forecast of rainfall, runoff from rainfall, forecasting stages, peak travel time, forecast reporting flood warning, engineering methods for flood fighting
5. Engineering Economics of Flood Control:
   Estimation of flood damages, estimation of benefits of flood control, cost benefit analysis of flood control project.

Unit-IV (9 hrs)

6. Design of Subsurface Drainage System
   Introduction, necessity for drainage, removal of drainage water, design of closed underdrains, design of open underdrains. Design for leaching requirements.
7. Design of surface drainage systems
   Necessity of surface drainage, surface drainage channels design considerations, general design consideration of outfall culvert, design consideration of tidal channels and outfall sluices

8. Application of remote sensing technology for flood control
   Introduction, application for planning flood control measures, flood warnings
9. Disaster Management concepts and approaches
   Introduction, man-made disaster, Disaster management in India

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Flood Control & Drainage Engineering by S. N. Ghosh
2. Hydrology & Flood Control Engg. by S. K. Garg
3. Hydrology & Water Resources Engg. by K. C. Patra
4. Disaster Management, Concepts and Approaches by D. Mondal & D. Basu
5. Elementary Hydrology by V. P. Singh

Course Outcomes:

Upon successful completion of the course, the students will be able to
CO1: know causes of flood and its problems
CO2: be familiar with flood mitigation techniques by river protection & reservoirs
CO3: know concept of flood forecasting techniques.
CO4: be acquainted with the surface and sub-surface drainage systems.

CEOE304 Environmental Planning and Management

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course is designed to provide students with the understanding of the concept of sustainable development, the strategies and barriers of sustainability, and to equip the students to apply pollution prevention and cleaner production techniques in industrial processes, and carry out waste audit and total cost analysis.

Course Content:

Unit-I **(9 lectures)**

Sustainable Development - Precautionary Principle, Polluter Pays Principle; Growth of Human Population – population explosion, effect and Indian scenario, environmentally sustainable and environmentally optimum populations.

Unit-II **(9 lectures)**

Malthus Hypothesis; Free access resources and Tragedy of Commons; Garrett Hardin's essay; modern solutions to Tragedy of Commons; Impact Equation and its implications for Sustainable Development.

Unit-III **(9 lectures)**

Environmental Management Hierarchy; Pollution Prevention and Cleaner Production; Cleaner Production/Waste Management Techniques – source reduction, process & equipment optimization, reuse, recovery & recycling, raw material substitution, and product innovation; Cleaner Production Assessment (CPA) and its logical steps.

Unit-IV **(9 lectures)**

Environmental Impact Statement; Total Cost Analysis (TCA) and methodologies; Carbon Credit and Carbon Trading – Sustainable Development through Carbon Trading; Carbon Sequestration; Waste Audit; ISO 14000 Series of Standards.

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Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Kirkby J., O'Keefe P. and Timberlake: Sustainable Development, Earthscan Publication, London, 1999.
2. Danoy G.E. and Warner R.F.: Planning and Design of Engineering Systems, Unwin Hyman Publications, 1969.
3. Bishop P.L.: Pollution Prevention: Fundamentals and Practice, McGraw Hill International, 2004.
4. Goetsch D.L. and Stanley D.: ISO 14000 Environmental Management, Prentice Hall, Upper Saddle River, NJ, 2001.
5. Chanlett E.T.: Environmental Protection, McGraw Hill Publication, USA, 1973

6. Koren H.: Handbook of Environmental Health and Safety -principle and practices, Lewis Publishers, 3rd Edition, 1995.
7. Harrison Lee: Environmental Health, and Safety Auditing Handbook, McGraw Hill Inc., USA, 1995.
8. Shaw I.C. and Chadwick J.: Principles of Environmental Toxicology, Taylor & Francis Ltd., 2000.

Course Outcomes:

At the end of the course student will be able to

1. Understand the concept and issues related with sustainable development and population growth.
2. Modify schemes applied at different governance levels to achieve sustainable innovation.
3. Prepare process flow diagram and material balance for various industrial processes.
4. Summarize various techniques for cleaner production and to apply environmental sustainable management concepts in industries.

CEOE305 Building Planning and Drawing

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Pre-requisite: None

Brief description of the course: Drawing is the language of Engineers. Building Planning and Drawing is the foundation course for Civil Engineering students. This course will cover: Fundamentals of Building Drawing; Fundamentals of Buildings; Climate and Its Influence on Building Planning; Orientation of Buildings; Principles of Planning of Buildings; Building Bye-Laws; Planning of Residential Buildings; Planning of Public Buildings; Green Buildings; Standard Guidelines for Building Drawing; Guidelines for Planning and Drawing of Building; services needed for the building.

Course Content:

Unit I: Introduction to Building Construction and Masonry (06)

a) Introduction to building construction– definition, types of building as per National Building Code. Building components and their basic requirements, i.e. substructure and superstructure requirements. Introduction to automation in construction

b) Masonry– Introduction of stone masonry and brick masonry, characteristics of good building bricks, IS specification and tests, classification of bricks, types of bonds: English, Flemish, Header, Stretcher, construction procedure, supervision. Recent trends in light weight construction Form work and casting procedure for reinforced concrete columns, R.C.C. beams, R.C.C. slabs, Slip form work, introduction of underpinning and Scaffolding.

Unit 2: Building Components (06)

a) Doors and Windows: Definition of technical terms, installation of doors and window frames and their size specifications, fixtures and fastenings. Different types of doorsand windows: Ventilators: purpose and types.

b) Arches and Lintels – Introduction of arch construction, Lintels: necessity and types, chajja or weather shade necessity and types.

Functional requirement of flooring, types of floor finishes and their suitability, Types of flooring.

Roofing Materials – galvanized iron pre-coated aluminium sheets, fiber sheets. Roof construction types and their suitability, method of construction, Protective Coatings with plastering and finishing.

Unit 3: Building Bye Laws and Introduction to Architectural Drawing (08)

a) Building Byelaws Necessity of bye-laws, plot sizes, road width, open spaces, floor area ratio (F.A.R.), concept of V.P.R. Marginal distances, building line, control line, height regulations, room sizes, Area calculations (built-up area, carpet area etc.), Rules for ventilation, lighting, Vertical circulation, Sanitation and Parking of vehicles. Minimum Standard Dimensions

b) Introduction to Architectural drawing: Principles of Building Planning and Principles of Architectural design relation between form and function, utility, aesthetics, Concept of Line plan, Developed Plan, Elevation, Section, Selection of scales for various drawings, dimensioning, abbreviations, and symbols as per IS 962, Elements of perspective drawings, parallel and angular perspective of small building elements

Unit 4: Residential Buildings, Public Building and Green Buildings (10)

a) Residential Buildings- Functional requirements and dimensions of Residential Buildings like Bungalows, Twin bungalows, Row houses, Apartment. Prepare Developed Plan, Elevation and Sectional Elevation of above mentioned categories. Design of staircase: Dog legged /Quarter turn

b) Green Building -Salient features, benefits, planning concepts of Green Building (site selection, orientation, sun path and wind diagram etc.), introduction to Leadership in Energy and Environmental Design (LEED)
c) Planning of Public Buildings- Functional requirements and dimensions and planning of Public Buildings like industrial buildings, commercial buildings, School, Colleges, Hostel, Auditorium, Restaurant/ Hotel building, Primary Health Center/Hospital, Shopping complex, Sports complex, Vegetable market, Post office, and Bank buildings.

Unit 5: Building Services (06)

Safety aspects and services –Fire load, grading of occupancies by fire loads, Evacuation Time, fire escape elements, Need for earthquake resistant structures. Noise and Acoustics – Sound insulation, Acoustical defects, Reverberation time, Sabine's formula, sound absorbents, planning for good acoustics. Ventilation – Necessity and types of Ventilation.
Lighting -Principles of day lighting, Solar energy systems for lighting (BIPV). Plumbing - Types of plumbing system.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Shah M.G. Kalec. M. & Patki SY Building Drawing, Tata Mcgraw Hill, New Delhi, 2000
2. Varghese P. C. Building construction, PHI Learning Pvt. Ltd., 2008.
3. Punmia B. C., Jain A. J. and Jain A. J. Building construction, Laxmi Publications, 2005.
4. Arora S. P., and Bindra S. P. The text book of building construction, Dhanpat Rai Publications, 2010.
5. Building Drawings with an integrated Approach to Built-Environment by M. G. Shah, C. M. Kale and S. Y. Patki, New Delhi, Tata McGraw Hill. (5th edition.)
6. Building Materials by S. K. Duggal, New Age International Publishers.
7. Building Construction by S.C. Rangwala, Charotdar Publications.
8. The construction of buildings; seventh edition, Vol.1 & Vol.2 by R. Barry, Oxford: Blackwell Science.
9. Building Materials Technology by Ruth T. Brantley & L. Reed Brantley, Tata McGraw Hill. 5. National Building Code (latest).
10. Building Design and construction by Frederick Merrit, Tata McGraw Hill.
11. I.S. 962 – 1989 Code for Practice for Architectural and Building Drawings.
12. Development plan and DCP Rules of urban local body, New Delhi, Volume 12

Course Outcomes: On completion of the course, learner will be able to

1. Identify types of building and basic requirements of building components.
2. Make use of Architectural Principles and Building byelaws for building construction.
3. Plan effectively various types of Residential Building/public Building/Green Building forms according to their utility, functions with reference to National Building Code.
4. Understand different services and safety aspects.

CEOE306 Basic Highway Design

Pre requisite: Elementary Mathematics and Physics

L	T	P	Credits	Total Contact hours
3	0	0	3	3

Brief description about the course: This course is to learn highway geometric design and basic traffic engineering. Students will get an exposure about highway horizontal and vertical alignment of roads and highways. Students will also be able to understand various traffic related issues.

Course Content:

Unit -I 6 hrs.

Introduction to highway geometric design: Development IRC geometric design polices, Definition and scope of geometric design, Primary and dependent design controls.

Unit -II 10 hrs.

Human and vehicle factors: Concepts and application of human factors in design and typical vehicle factors used in geometric design.

Sight distance: Overview of different type of sight distance, sight distance index, scaling and recording sight distance from plans, sight distance profile.

Unit -III 14 hrs.

Longitudinal Features of Horizontal and Vertical Profile: Factors influencing profile selection, horizontal curve, vertical curve, curves for special situation, characteristics of highway alignment, general principles of horizontal and vertical profile coordination and technique, elements of highway cross sections, developing cross sections, methods of attaining super elevation and graphical development of super elevation.

Unit -IV 6 hrs.

Introduction to Traffic engineering: Traffic Studies, Design capacity and Level of Service, Parking studies and Accident studies, Traffic operations: Traffic regulations, Traffic control devices, Control of access on highways

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. A policy on geometric design of highways and streets, American Association of State Highway Officials, 2011.
2. Geometric design standards for urban roads in plains (IRC: 86- 1983), The Indian Roads Congress, 1983.
3. Geometric design standards for rural (non-urban) highways (IRC: 73-1980), The Indian Roads Congress, 1980.
4. Guidelines for expressways – Part I, Ministry of Road Transport & Highways, 2010.
5. Roadside design guide, American Association of State Highway Officials, 2002.
6. Various other relevant codes on geometric design such as IRC: SP:87-2010, IRC: SP:84-2009, IRC: SP:48-1998, IRC:92-1985
7. Pline, J.L., Traffic Engineering Handbook, Institute of Transportation Engineers, 2009.
8. S.K. Khanna and C.E.G. Justo, Highway Engineering, Khanna Publishers, Roorkee, 2001

Course Outcomes: Upon completion of this course, the students should be able to

CO1. Understand the concepts of cross-sectional elements of highway
CO2. Workout sight distance requirements
CO3. Design horizontal and vertical alignment
CO4. Understand traffic operations and traffic control measures

Open Electives (OE)

B.Tech. 6th Semester

CEOE307 Geotechnical Exploration and Field Testing

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course has been designed to provide students with the knowledge of various direct and indirect methods of soil exploration. On completion of the course, the students shall be able to plan and execute sub-soil exploration programme for different field projects.

Course Content:

Unit-I (8 hrs.)

General: Purpose of soil exploration, preliminary investigations, site reconnaissance, phasing of soil exploration.

Excavation and Boring Methods: Exploration by pits, trenches, drifts and shafts, augur boring, shell and augur boring, wash boring, percussion drilling, rotary drilling, stabilization of bore holes.

Unit-II (8 hrs.)

Sampling Techniques: Sample disturbance, type of soil samples, design features of sampler affecting sample disturbance, type of samplers, open drive samplers - thin wall, thick wall and split spoon samplers, rotary sampler, rock core drilling, core catcher, sampling from test pits, procuring and handling of disturbed and undisturbed samples.

Unit-III (12 hrs.)

Field tests: Standard penetration test (SPT), static cone penetration test (SCPT), dynamic cone penetration test (DCPT), in-situ vane shear test, in-situ permeability tests, plate load test, pressure meter test.

Geophysical Methods: Seismic refraction method, electrical resistivity method - resistivity sounding and resistivity profiling.

Unit-IV (8 hrs.)

Recent Trends in subsurface exploration, important role of remote sensing, comparison with conventional methods.

Planning and Execution of Sub-soil Exploration Programme: Depth and lateral extent of exploration for different Civil Engineering Works, ground water observation, field tests vis-à-vis lab tests, bore logs, soil investigation report, planning of exploration and testing programme for different field projects.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Soil Engineering in Theory and Practice, Vol. II, Geotechnical Testing and Instrumentation by Alam Singh.
2. Principles of Geotechnical Engineering by B M Das.
3. Basic and Applied Soil Mechanics by Gopal Ranjan and A S R Rao.
4. Text Book of Soil Mechanics and Foundation Engineering by V N S Murthy

Course Outcomes:

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

CO1: Understand various methods of soil exploration including boring methods.

CO2: Categorize various type of soil samples and understand various sampling techniques.

CO3: Understand field tests and geophysical methods of soil exploration.

CO4: Plan soil exploration programme including preparation of report of soil investigation.

CEOE308 Draught & Flood

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The subject deals with basic concepts and principles of drought and flood. It helps to estimate and analyze the drought & flood, and explains preventive measures to prevent the drought & flood. Also, it provides student knowledge of shortage and excess of precipitation and its impact on human life.

Course Content:

Unit-I (8 hrs)

Drought (6 hrs)
Definition, causes, types, effects of drought, indices, management, water harvesting.

Flood Problems (2 hrs)
Causes, alleviation

Unit-II (12 hrs)

Estimation of design floods (6 hrs)
Methods of computations

Flood routing through reservoirs and channels (6 hrs)
Puls method, Muskingum method

Unit-III (9 hrs)

Spillway designs (5 hrs)
Functions, types and design

Flood mitigation (4 hrs)
Various types of storages, Reservoir operation, river improvement works

Unit-IV (7 hrs)

Flood forecasting, warning and fighting (3 hrs)
Forecasting techniques, engineering measures for flood fighting

Design of subsurface drainage systems (4 hrs)
Necessity, design of underdrains

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Engineering Hydrology by K.Subramanya.
2. Hydrology for Engineers by Linsely, Kohler, Paulhus.
3. Flood Control and Drainage Engineering by S.N. Ghosh
4. Water Resources Engineering by Larry W. Mays
5. Land drainage Principles, methods and applications by A K Bhattacharya and A M Micael

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

1. Understand the basic principles of drought and flood.
2. Measure the flow of water through the channel and watershed area.
3. Understand preventive measures to prevent the drought and flood.
4. Understand methods of design structures required for the mitigation of flood.

CEOE309 Ecology and Biodiversity Conservation

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course:
The course is designed to provide students with the knowledge of ecology and its importance. The course covers a wide range of topics, including natural resources and associated problems, ecosystems, biodiversity and conservation for sustainable development.

Course Content:

Unit-I (10 lectures)
Global environment, impact of humans upon environment, impact of environment upon humans. Natural resources and associated problems – use and over-exploitation of forest, water, mineral and land resources. Renewable and non-renewable energy sources and their impact on environment, case studies in Indian context. Need of sustainable development.

Unit-II (8 lectures)
Ecology, Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow and routes of usage in the ecosystem, Biogeochemical cycles, Food chains and food webs, Trophic level, ecological pyramids, and Ecological succession.

Unit-III (8 lectures)
Ecological balance in nature, Consortism - concept and ranks/types. Types, characteristic features, structure and function of the various types of ecosystem – Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries), etc.

Unit-IV (10 lectures)
Introduction – Definition : genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-sports of biodiversity, Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Indigenous and sustainable technologies/models/techniques for ecosystem and biodiversity conservation – sacred groves, animal-human symbiotic relationship, etc.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Fundamentals of Ecology by E. P. Odum
2. Ecology and Environment by P.D. Sharma
3. A basic Course in Environmental Studies by S. Deswal and A. Deswal

4. The Biodiversity of India by Bharucha Erach

Course Outcomes:

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

CO1: Understand importance of natural resources and sustainable development

CO2: Understand the concept and energy flow in an ecosystem, and values of biodiversity

CO3: Take appropriate measures for ecosystem and biodiversity conservation to maintaining ecological balance.

CO4: Involve all stakeholders for sustainable development of society.

CEOE310 Sustainable Infrastructure

Pre requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief Description about the course:
This course develops engineering skills with the focus on planning, design, and construction of sustainable infrastructure with the key purpose to support and connect our communities. It is not simply the short-term provision of infrastructure that is of prime importance but planning and designing infrastructure which takes full account of its own impact and its operational needs and use. Sustainable infrastructure design is not just about new infrastructure, it is about rehabilitation, reuse, or optimization of existing infrastructure. Infrastructures should set an aim to set a responsible standard of sustainable design in both the short- and the long-term. Infrastructure must be sustainable if it is to benefit coming generations and make a positive contribution to the future. Students will learn how to use their knowledge of these processes by designing sustainably and quantitatively assess alternative design options. Design-based problems and case studies are used to build on theory and challenge students to use their skills in applied settings.

Course content:
Unit I - 12 hrs.
Examine systems theory as a tool throughout the conception, analysis, and design of technological systems operating in modern societies and embedded within the natural environment for buildings, structures, plants and networks for communication and transport, water and wastewater treatment, production, and distribution of energy; relations between infrastructure and sustainable development
Unit II - 8 hrs.
Regulations and standards; indicators of sustainability; consequences of climate change; vulnerability and safety of infrastructure;
Unit III - 8 hrs.
Materials and technology for construction and management; Applications for sustainable communities; service life and life cycle assessments
Unit IV - 8 hrs.
Case studies from around the world.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:
1. Sarte S. B., ‘Sustainable Infrastructure: The Guide to Green Engineering and Design, Wiley; 1st edition, 2010.
2. Horne R. E., Grant T., Verghese K., ‘Life Cycle Assessment: Principles, Practice and Prospects’, CSIRO, 2009.
3. Karli Verghese, Helen Lewis, Leanne Fitzpatrick, ‘Packaging for Sustainability’, Springer, 2012.

Course Outcomes:

On completion of the course, the students will be able to:

1. understand the values and societal importance of the built environment.
2. understand the influence on a sustainable development.
3. gain knowledge on how to use environmental impact assessments as a tool for design.
4. understand construction and management of a sustainable built environment.

CEOE311 Transportation Economics and Finance

Pre requisite: None

L	T	P	Credits	Total Contact hours
3	0	0	3	3

Brief description about the course: This course is to learn about transportation cost, to understand the vehicle operating cost. This course will help the students to be familiarize with the formulation of project alternatives and applying the economic analysis methods and to understand the principles and procedure of financing of road projects.

Course Content:

Unit-I 8 hrs.

Transportation costs - Classification of transportation costs, transportation agency costs, transportation user costs, general structure and behavior of cost functions and road pricing. Estimating Transportation Demand and Supply - supply equilibration, dynamics of transportation demand and supply, elasticity of travel demand and supply, classification of elasticity.

Unit-II 10 hrs.

Vehicle operating costs: Fuel costs - Maintenance and spares, Depreciation - Crew costs - Value of travel time savings - Accident costs. Economics of traffic congestion - Pricing policy.

Unit-III 10 hrs.

Economic analysis of projects - Methods of evaluation - Cost-benefit ratio, first year rate of return, net present value, and internal-rate of return methods; Indirect costs and benefits of transport projects.

Unit-IV 8 hrs.

Financing of road projects - methods – Private Public Partnership (PPP) - Toll collection - Economic viability of Design-Build-Operate-Transfer Schemes – Risk Analysis – Value for Money analysis - Case Studies.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Winfrey, Economic analysis for Highways, International Textbook Company, Pennsylvania, 1969.
2. CRRI, Road User Cost Study in India, New Delhi, 1982
3. IRC, Manual on Economic Evaluation of Highway Projects in India, SP30, 2007

Course Outcomes:

Upon completion of this course, the students should be able to

CO1. understand the concepts of decision making.
CO2. estimate vehicle operation cost and accident cost.
CO3. perform economic analysis of a transportation project.
CO4. apply various financing methods in road projects.

Open Electives (OE)

B.Tech. 7th Semester

CEOE401 Machine Foundations

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This course will help the students understand principles of foundation design for industrial machines, and the concept and methods of vibration isolation.

Course Content:

Unit-I (12 hrs)

Theory of Vibrations: Definitions, harmonic motion, vibrations of a single degree freedom system, transmissibility, theory of vibration measuring instruments.

Unit-II (5 hrs)

General Principles of Machine Foundation Design: Types of machines and machine foundations, criteria for satisfactory action of a machine foundation, permissible amplitude, allowable soil pressure, permissible stresses in concrete and steel, permissible stresses in timber.

Evaluation of Parameters: Modes of vibration of a rigid block foundation, Barkan's soil spring constants, determination of coefficients of elastic uniform compression and Elastic uniform shear.

Unit-III (13 hrs)

Foundations for Reciprocating Machines: Analysis of block foundation by Barkan's theory of linear elastic weightless spring analogy, Indian Standard for design and construction of foundation for reciprocating machine, design procedure, design examples.

Foundation for Impact Machines: Dynamic analysis, Barkan's recommendations for weight and base contact area, IS Code practice for design and construction of foundations for impact machines, design procedure, design examples.

Foundations for Rotary Machines: Special considerations, design criteria, methods of analysis and design.

Unit-IV (6 hrs)

Vibration Isolation and Screening: Active isolation, passive isolation, methods of isolation, wave screening, vibration absorbing materials, planning for vibration isolation.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Dynamics of Bases and Foundations by D. D. Barkan
2. Soil Dynamics by Shamsher Prakash
3. Soil Dynamics and Machine Foundations by Swami Saran
4. Principles of Soil Dynamics by Braja M. Das
5. Vibration and Shock Isolation by Crede

Course Outcomes:

On completion of the course, the students shall be able to:

CO1	Understand theory and principles of design.
CO2	Evaluate and select parameters for design.
CO3	Design foundations for industrial machines.
CO4	Propose vibration and shock isolation techniques for various projects.

CEOE402 Ground Water Engineering

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course is divided into four units, with Unit I covering aquifer properties, groundwater flow equations, exploration techniques, and determination of hydraulic properties. Unit II focuses on tube well design, construction, working, pumping equipment, and hydraulic testing. Unit III explores artificial recharge methods, Ghyben-Herzberg relation, and control of saltwater intrusion. Finally, Unit IV/V addresses urban water demand management, rainwater harvesting, groundwater modelling, and integrated water resources management and governance.

Course Content:

Unit-I (9 hrs)

Properties of Aquifers, Formation constants, compressibility of aquifers, Equation of motion for steady and unsteady ground water flow in isotropic homogeneous aquifers, Dupit's assumptions. Unconfined flow with a recharge, tiled train problem. Ground water exploration and methods of investigations. Effect of boundaries, interference of water, leaky aquifers, Thiem's equilibrium formula for unconfined and confined aquifers and determination of hydraulic properties of aquifers. Non equilibrium formula for aquifer (unsteady radial flows).

Unit-II (7 hrs)

Tube wells, optimum capacity, silting of tube well, design of tube wells in different aquifers, tube well types, parts, bore hole, strains, its types, well pipe, casing pipe, blind pipe. Construction and working of tube wells, site selection, drilling operation, cable tool method, hydraulic method, Rotary Method and drilling fluids, well screen assembly installation, verticality and alignment of tube wells, gravel packing, development of tube wells, sickness, corrosion and failure of tube wells, Pumping equipment and hydraulic testing of pumps.

Unit-III (11 hrs)

Artificial recharge of ground water, considerations and methods, recharge techniques induced infiltration, water spreading, flooding, basins, ditching, modification of natural channels, irrigation, recharge pits, shafts and recharge wells

Ghyben-Herzberg Relation between fresh and saline water shape and structure of fresh water and salt water interface, upcoming saline water, fresh water and salt water relations on oceanic islands Occurrence of saline water intrusion, Control of salt water intrusion, Recognition of sea water in the ground water.

Unit-IV (9 hrs)

Urban Water Demand Management: Investigate and develop sustainable strategies for managing water demand in urban areas, including efficient water use practices, conservation measures, and public awareness campaigns.

Rainwater Harvesting and Storm Water Management: Study the implementation of rainwater harvesting systems and sustainable storm water management techniques to recharge groundwater and reduce runoff in urban environments.

Groundwater Modelling and Simulation: Develop numerical models and simulation tools to assess the impact of urbanization on groundwater resources, evaluate different management scenarios, and optimize sustainable groundwater allocation strategies.

Integrated Water Resources Management & Policy and Governance

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Ground water Hydrology, D. K. Todd, John Wiley & Sons Inc. New York.
2. Groundwater, H.M. Raghunath, Wiley Eastern Ltd., N. Delhi
3. Karamouz, M, Ahmadi, A, and Akhbari, M, Groundwater Hydrology: Engineering, Planning and Management, CRC Press
4. Ground Water Hydrology, V.C. Aggarwal, PHI Learning Private Limited New Delhi
5. Davis, S.N., and De Weist, R.J.M., Hydrogeology, John Wiley & Sons, New York
6. Domenico, Concepts and Models in Groundwater Hydrology, McGraw Hill Inc. New York.

Course Outcomes:

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

CO1: Course imparts aquifer knowledge, flow equations, exploration, and data analysis for informed groundwater resource management.

CO2: Study consist of a comprehensive knowledge guides tube well design, construction, operation, and maintenance, improving efficiency, longevity, and performance.

CO3: Study outcomes on artificial groundwater recharge, Ghyben-Herzberg relation, and saltwater intrusion improve groundwater management, freshwater-saltwater dynamics understanding, and sustainable water resource management strategies.

CO4: Learning outcomes contribute to sustainable water management, urban water systems understanding, and policies promoting efficient water use and integrated water resources management.

CEOE403 Pollution Control and Waste Management

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course:
The course is designed to provide students with the knowledge of environmental pollution and its control. The course covers a wide range of topics, including water pollution, air pollution, noise pollution, and solid waste management.

Course Content:

Unit-I **(10 lectures)**
Water Pollution
Sources, effects and control of water pollution. Characterization of waste water, composition of domestic and industrial waste water, decomposition of organic matter, self-purification of natural rivers/streams. Standards for discharge of effluents in waterbodies. Objectives of wastewater treatment, classification of treatment process. Flow scheme of conventional sewage treatment plant and functions of treatment units – preliminary, primary, secondary and tertiary treatment units.

Unit-II **(10 lectures)**
Air Pollution
Composition and structure of atmosphere, classification and sources of air pollutants, effects of air pollution on plants, animals, human health, economic effects of air pollution, greenhouse effect and global warming, ozone layer depletion and acid rains. Meteorological parameters influencing air pollution. Air quality standards and air quality index, automobile pollution - effects and control measures. Atmospheric self – cleansing processes, approaches and techniques of air pollution control. Air pollution control devices: Gravitational settling chamber, cyclones, wet scrubbers, fabric filters, ESP and catalytic converters.

Unit-III **(6 lectures)**
Noise Pollution
General introduction to noise pollution, human acoustics, unit of measurement, loudness, measurements of noise and weighting networks, sources and effects of noise pollution, noise abatement/control, noise standards.

Unit-IV **(10 lectures)**
Solid Waste Management
Definition, types, composition and sources of solid wastes, Solid Waste Management Rules (2016), storage and collection of municipal solid waste, methods of solid waste disposal – composting, incineration, pyrolysis and sanitary land filling, recovery of materials and energy from solid waste.
Water conservation, indoor air pollution control, composting and biogas plants, bioremediation and phytoremediation using indigenous techniques.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Environmental Engineering by H. S. Peavy, D. R. Rowe and G. Tchobanoglous
2. A basic Course in Environmental Studies by S. Deswal and A. Deswal
3. Air Pollution by M. N. Rao
4. Environmental Noise Pollution by P. F. Cuniff
5. Solid Waste Management Collection, Processing and Disposal by A. D. Bhide and B. B. Sundaresan

Course Outcomes:

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

CO1: Understand the sources, characterization and treatment of waste water

CO2: Identify the types, sources, effects and control of air pollutants

CO3: Understand the sources and effects, and select appropriate measures for noise pollution control

CO4: Understand the various functional elements involved in solid waste management.

CEOE404 Theory of Elasticity and Plasticity

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This course is a general introduction to the theory of elasticity. This is the single most important branch of solid mechanics. It encompasses the mechanical behavior of an enormous variety of engineering and natural materials and provides a template for the formulation of more advanced models of complex material behavior, such as plasticity, growth and thermos-mechanics. This course will cover: the basic concept of elasticity, its relationship to work and energy, the concepts of frame invariance and material symmetry, stress and strain relationship, Airy's stress function and its use in analysis of 2D problems as well as covers the plastic behaviour and application of failure theories to brittle and ductile materials.

Course content:

UNIT 1: (06)

Basic concepts of deformation of bodies – deformation gradient- Tensor notations of stress and strain in 3D field - Traction - Engineering and Cauchy stress and Green- Lagrange Strains - Cauchy form of equilibrium equation - Transformation of stress and strain in a 3D field - Equilibrium equations in 2D and 3D Cartesian coordinates

UNIT 2: (10)

Concept of Orthogonal Transformation of axes and Problems, Determination of Stress invariants Compatibility equations - Stresses: Principal, Octahedral, Hydrostatic and deviatoric - Derivation of Constitutive law - reduction to isotropic and uniaxial case.

Concept of Strain at a point, Determination of Normal and Shear Strain, Generalized Hooke's Law and problems on interrelationship between stress and Strain in three dimensions.

UNIT 3: (08)

Formulation of a stress analysis problem using the necessary and sufficient conditions in three dimensions and modifying the same to identify the unknowns in plane cases, Derivation of Airy's Stress function using the boundary conditions, equilibrium equations, compatibility conditions. Plane stress and plane strain problems - 2D problems in Cartesian coordinates as applied to beam bending using Airy's stress function and examples - Problems in 2D

UNIT 4: (06)

Torsion of non-circular sections - St. Venant's theory – Torsion of elliptical sections - Torsion of triangular sections - Prandtl's membrane analogy - Torsion of rolled profiles - Torsion of thin walled tubes

UNIT 5: (06)

Plasticity – Introduction - Reasons of plasticity - slip lines - Plastic stress-strain relations - Flow rules (associated and non associated) - Different hardening rules - Yield criteria for ductile and brittle materials - Graphical representation of yield criteria.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Srinath, L.S., Advanced Mechanics of Solids, Tata McGraw Hill, 2010
2. Schmidt, R.J. and Boresi, A.P., Advanced Mechanics of Materials, Wiley, 2002
3. Hibbeler, R.C., Mechanics of Materials, Pearson, 2016
4. Timoshenko, S.P. and Gere, J.M. Mechanics of Materials, Tata McGraw Hill, 1992
5. Rees, D.W.A., Basic Engineering Plasticity, Butterworth-Heinemann, 2006
6. Sadhu Singh, Applied Stress Analysis, 4th Edition, Khanna Publishers, New Delhi.
7. J.W. Dally and W. F. Riley, Experimental Stress Analysis, 3rd Edition, Mc Gram Hill.

Course Outcomes:

On completion of the course, the students will be able to

1. Relate various stress and strain measures and perform transformation between different bases.
2. Determine principal, hydrostatic and octahedral stresses for given stress state.
3. Obtain the solution to classical problems using the Airy stress function approach.
4. Understand the behaviour of non-circular and open sections in torsion.
5. Gain a basic introduction to the plastic behaviour in materials and application of failure theories of brittle and ductile materials.

CEOE405 Traffic Engineering and Road Safety

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course:
Traffic Engineering utilises principles of Engineering to ensure a secure and efficient movement of people and materials on several modes of transport and road networks. The objective of the course is to give insight about traffic characteristics, traffic control, regulation and management measures. Road traffic safety refers to the methods and measures used to prevent road users from being killed or seriously injured.

Course Content:

UNIT-I 8 hrs
Organisational set up of traffic engineering department in India. Traffic characteristics. Max dimensions and weights of vehicles. Traffic growth. Traffic studies. Accident statistics, Accident study. Parking Issues. Road alignments and road geometrics affecting road safety. Land use planning and road safety.

UNIT-II 10 hrs
Space and time headway. Fundamental diagram of traffic flow. Relationship between speed, volume and density. Level of service. PCU. Design service volume. Capacity of non-urban & urban roads. Road congestion and road safety. IRC recommendations. Traffic control devices. Signal & Intersection Designs. Road markings, Traffic control aids and street furniture. Traffic control devices and road safety.

UNIT-III 10 hrs
Traffic regulations. Regulation of speed, vehicles and drivers. General traffic regulations. Motor vehicle act. Scope of traffic management. Traffic management measures: restrictions on turning movements, one way streets, tidal flow operations, exclusive bus lanes, traffic restraint, road pricing. Enforcement and education measures for road safety.

UNIT-IV 8 hrs
Road safety audit, RSA team, RSA Report, Elements of RSA, Detrimental effects of traffic. Vehicular air pollution. Situation in India. Vehicular emission norms in India and abroad. Alternate fuels. Factors affecting fuel consumption. Arboriculture.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Traffic Engg. and Transportation Planning by L. R. Kadiyali, Khanna Publishers, Delhi, 2002.
2. Highway Engg by S. K. Khanna & C.E.G. Justo, Veeraragavan A., Nem Chand Bros., Roorkee, 2014

3. Traffic Engg. by Matson, T.M., Smith, W.S. and Hurd, F.W., McGraw- Hill Book Co., New York.
4. Traffic Flow Theory by Drew, D.R., McGraw- Hill Book Co., New York.
5. Trainers Road Safety Manual, NHA and Ministry of Shipping, Road Transport and Highways, Govt of India.

Course Outcomes:

On completion of the course, the students shall be able to:

1. Gain Engineering knowledge of the subject and apply it for the solution of problems related to road safety.
2. Design geometrics, signals and intersections, make investigations, use modern tools and develop solutions to traffic problems including safety of road users.
3. Understand the engineering solutions in societal and environmental context for sustainable development that takes care of pollution and environment.
4. Understand the norms of engineering practice and the need for life-long learning as per their exposure to relevant latest IS/IRC/MoRTH specifications.

CEOE406 Geoinformatics

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This course will help students to understand the importance of advanced methods of surveying using photogrammetry, GPS as well as use of remote sensing and GIS for different applications in engineering and science.

Course Content:

Unit-I (9 hrs)

Elements of Photogrammetry: History, Introduction, types of photographs, Terrestrial and aerial photographs, aerial, camera, scale and height displacements of vertical photographs, Stereoscopic vision and stereoscopes, height determination from parallax measurement, flight planning, principle of photo interpretation, use of UAV in photogrammetry

Unit-II (9 hrs)

Global Navigation Satellite System (GNSS): History of GPS, Basic concepts, GPS design objectives and details of segments: space, control and user. Brief of different GPS systems, including, NAVSTAR GPS, GLONASS, GALILEO, IRNSS, BeiDou etc, Advantages and limitations of GPS. GPS Signal structure: Carriers frequencies, GPS codes: C/A, P, navigational message, GPS receiver: Types. Principles of GPS position fixing, Pseudo ranging and carrier phase, GPS errors.

Unit-III (9 hrs)

Introduction to remote sensing: Basic theory, types of remote sensing and remote sensing system. EMR source and characteristics, active and passive remote sensing, EMR interaction with atmospheric and object. Atmospheric windows. Spectral signature, EMR interaction with vegetation, soil and water. Satellite orbits and platforms: Geostationary and sun synchronous satellites, image Resolution. Basic operations on satellite image including preprocessing (image rectification, enhancement, filtering etc) and classification.

Unit-IV (9 hrs)

Geographical Information System (GIS): Definition and Objectives, Components of GIS, Spatial data models: Raster and Vector, Data inputting in GIS, Linkage between spatial and non-spatial data, Spatial data analysis: Vector and raster based spatial data analysis, Integration of RS and GIS data, Digital Elevation Model/Digital terrain model. Role of GIS and remote sensing in sustainable development

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. A. M. Chandra: Geoinformatics, New Academic Science
2. Mario A. Gomarasca, Basics of Geomatics, Springer
3. Paul R. Wolf, Bon A. DeWitt, Benjamin E. Wilkinson: Elements of Photogrammetry with Application in GIS, McGraw-Hill Education
4. Basudeb Bhatta: Remote Sensing and GIS, OUP India
5. Ahmed El-Rabbany: Introduction to GPS: The Global Positioning System
6. Various Online resources including NPTEL

Course Outcomes:

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

CO1: understand the concept of acquiring photographs and images

CO2: understand the working of global navigation satellite system to determine location

CO3: Understand the working of remote sensors

CO4: understand how to use GIS for various applications

Open Electives (OE)

B.Tech. 8th Semester

CEOE407 Geotechnical Earthquake Engineering

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This course has been designed to provide students fundamental knowledge of soil dynamics and seismic behaviour of soils.

Course Content:

Unit-I (6 hrs)

Introduction: Seismic hazards, mitigation of seismic hazards, significant historical earthquakes.

Seismology and earthquakes: Internal structure of earth, continental drift and plate tectonics, faults, elastic rebound theory, location of earthquakes, size of earthquakes.

Unit-II (10 hrs)

Strong ground motion: Strong motion measurement, ground motion parameters, estimation of ground motion parameters, spatial variability of ground motions.

Seismic hazard analysis: Identification and evaluation of earthquake sources, deterministic seismic hazard analysis (DSHA), probabilistic seismic hazard analysis (PSHA).

Unit-III (8 hrs)

Wave propagation: Waves in unbounded media, waves in semi-infinite body, waves in a layered body, attenuation of stress waves.

Dynamic soil properties: Measurement of dynamic soil properties, stress-strain behaviour and strength of cyclically loaded soils.

Unit-IV (12 hrs)

Ground response analysis: One-dimensional, two-dimensional and three-dimensional ground response analyses.

Local site effects and design ground motions: Effect of local site conditions on ground motion, design parameters, development of design parameters, development of ground motion time histories.

Liquefaction: Liquefaction related phenomena, evaluation of liquefaction hazards, initiation of liquefaction, effects of liquefaction, case studies.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Kameswara Rao, N.S.V., Dynamics soil tests and applications, Wheeler Publishing.
2. Kramer S.L., Geotechnical Earthquake Engineering, Prentice Hall, International Series, Pearson Education.
3. Kameswara Rao, Vibration Analysis and Foundation Dynamics, Wheeler Publishing.
4. Robert W. Day, Geotechnical Earthquake Engineering Hand book, McGraw Hill.
5. Debashis Moitra, Geotechnical Engineering, Universities Press.

Course Outcomes:

On completion of the course, the students will be able to

1. Understand principles of seismology as applied to engineering.
2. Understand characteristics and parameters of strong ground motion.
3. Understand necessary conceptual and analytical background for seismic hazard assessment.
4. Estimate seismic soil design parameters.
5. Understand mechanism of ground failure due to earthquakes and related phenomena.

CEOE408 Hydro Power Engineering

Pre-requisite: Elementary knowledge of Electrical, Mechanical and Civil engineering

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: The course covers various aspects of hydropower development, including power sources, small hydro importance, types of power plants, intake structures, penstocks, turbines, power house layouts, and sustainable technologies. Students learn about environmental impact assessment, mitigation measures, stakeholder engagement, and project management principles for responsible hydropower development.

Course Content:

Unit-I (9 hrs)

Introduction

Sources of power, estimation of water power, necessity and importance of harnessing small hydro power, flow duration and power duration curves, load curve, load factors, capacity factors, utilization factors, firm and secondary power.

Types of Hydro Power Plants

Elements of Hydro power, classification of hydro-power plants, run-of-river plants, storage plants diversion canal development, pumped storage plants, tidal power plants, base load and peak load plants in a power grid

Unit-II (7 hrs)

Intakes

Intake structures, functions and their types, components of intakes-forebay, trash racks, gates and valves, force required to operate gates.

Conveyance System

Penstocks, design criterion, economical diameter anchor blocks, cradles and footings, water hammer, instantaneous closure of power canal, surge tank, surges in canals.

Unit-III (11 hrs)

Turbines

Types of turbines, specific speed and classification of turbines, synchronous speed, scroll casing, flumes and draft tubes, dimensions of scroll casing and draft tubes, setting of turbines

Power House

General layout and arrangements of hydro-power units, number and size of units, sub-structure, spacing of units, super-structure, underground power stations, tidal power.

Unit-IV (9 hrs)

Environmental and Social Aspects: Environmental impact assessment (EIA) for hydropower projects. Mitigation measures for minimizing the ecological and social impacts of hydropower development. Social and community considerations, including stakeholder engagement and resettlement issues. Sustainable Hydropower Technologies Policy, Economics, and Project Management:

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Water Power Engineering, Dandekar, M. M., Sharma, K. N.
2. Hydro-Electric Engineering Practice Vol. I, II & III Brown J. G.
3. Water Power Engineering, Borrows, H. K.
4. Water Power Development, Vol. I & II, Mosonyi, E.
5. Water Power Engineering, M. M. Deshmukh

Course Outcomes:

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

CO1: Students gain a comprehensive understanding of hydropower sources, small hydro importance, plant types, power generation, analysis, and sustainability.

CO2: Students acquire broad knowledge of intake structures, components, design, penstocks, sizing criteria, water hammer phenomena, and surge control techniques.

CO3: Students learn turbine types, selection factors, components (scroll casings, flumes, draft tubes), power house layout, underground stations, and tidal power projects for effective hydropower plant design and operation.

CO 4 Students gain complete knowledge of hydropower's environmental and social aspects, enabling impact assessment, stakeholder engagement, and responsible development.

CEOE409 Environmental Ethics and Legislation

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course:
The course is designed to provide students with the knowledge and awareness of environmental ethics, sustainable development, constitutional provisions and role of judiciary in promoting environment, forms of legislation and issues in enforcement, environmental acts and legal aspects of environmental problems.

Course Content:

Unit-I **(9 lectures)**
Environmental Ethics
Sustainable development, Environmental ethics - meaning, type, need, issues and possible solutions. Constitutional provisions and Environment protection in India, National Environmental policies, Sustainable development and role of Indian Judiciary in promoting it.

Unit-II **(9 lectures)**
Environmental Acts
Water (P&CP) Act 1974, Air (P&CP) Act 1981, and Environment (Protection) Act 1986. Relevant provisions of Forest (Conservation) Act 1982, Wild Life (Protection) Act 1972.

Unit-III **(9 lectures)**
Environmental Legislation
Forms of legislation / regulations - multilateral environmental agreements, conventions and protocols. Issues involved in enforcement of Environmental Legislation. Precautionary Principle and Polluter Pays Principle – Concept of absolute liability. Public interest litigation, Writ petitions.

Unit-IV **(9 lectures)**
Supreme Court Judgements in landmark cases
Indian Council for Enviro-legal Action v. UOI AIR 1996 SC 1446, MC Mehta v. Union of India (Oleum gas leak case) AIR 1987 SC 1086, MC Mehta v. UOI (Kanpur Tanneries case), Indian Handicraft Emporium v. UOI (2003) 7 SCC 589, and other landmark cases.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Divan S. and Roseneranz A.: Environmental law and policy in India – Cases, Material & Statements, Oxford University Press, New Delhi, 2001.
2. CPCB: Pollution Control Acts, Rules and Notifications issued there under Pollution Control Series, Central Pollution Control Board, N. Delhi.
3. Diwan P.: Environmental administration –law and judicial attitude Vols. I & II, Vedams eBooks (P) Ltd, N. Delhi, 1992.

4. Jaswal P.S. and Nistha: Introduction to Environmental Law, Allahabad Law Agency, Allahabad, 2017

Course Outcomes:

At the end of the course student will be able to

1. Understand and imbibe environmental ethics.
2. Have an understanding of the Indian policies and legislation pertaining to prevention and control of environmental pollution.
3. Have an insight into the environmental protection acts.
4. Critically examine the legal aspects of environmental issues and to transfer theoretical knowledge to new environmental situations

CEOE410 Life Cycle Analysis and Design for Environment

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course:
The course is designed to provide students with the understanding of engineering products and processes, and their environmentally conscious design that include pollution prevention and cleaner production, along with life cycle analysis and ISO environmental management standards.

Course Content:

Unit-I (9 lectures)
Sustainable Development; Engineering products and processes: Environmental health and safety, product life cycle stages, material toxicity, pollution, and degradation, environmentally conscious design and manufacturing approaches.

Unit-II (9 lectures)
Design for Environment: Motivation, concerns, definitions, examples, guidelines, methods, and tools. Recyclability assessments, design for recycling practices. Re-manufacturability assessments, design for Remanufacture / Reuse practices. Pollution prevention practices, Manufacturing process selection and trade-offs.

Unit-III (9 lectures)
Environmental Management Hierarchy; Pollution Prevention and Cleaner Production; Cleaner Production/Waste Management Techniques – source reduction, process & equipment optimization, reuse, recovery & recycling, raw material substitution, and product innovation; Cleaner Production Assessment (CPA) and its logical steps.

Unit-IV (9 lectures)
Industrial ecology, eco-industrial parks and eco-labels; Life-cycle analysis (LCA) - methodology, steps, tools and problems; life-cycle accounting and costing; System life-cycles from cradle to reincarnation, product life-extension, organizational issues. ISO 14000 Environmental Management Standards; New business paradigms and associated design practices.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Kirkby J., O'Keefe P. and Timberlake: Sustainable Development, Earthscan Publication, London, 1999.
2. Danoy G.E. and Warner R.F.: Planning and Design of Engineering Systems, Unwin Hyman Publications, 1969.
3. Harrison, Lee (1995) Environmental Health, and Safety Auditing Handbook, McGraw Hill Inc., USA.

4. Bishop P.L.: Pollution Prevention: Fundamentals and Practice, McGraw Hill International, 2004.
5. Goetsch D.L. and Stanley D.: ISO 14000 Environmental Management, Prentice Hall, Upper Saddle River, NJ, 2001.
6. Chanlett E.T.: Environmental Protection, McGraw Hill Publication, USA, 1973
7. Koren H.: Handbook of Environmental Health and Safety -principle and practices, Lewis Publishers, 3rd Edition, 1995.
8. Harrison Lee: Environmental Health, and Safety Auditing Handbook, McGraw Hill Inc., USA, 1995.
9. Shaw I.C. and Chadwick J.: Principles of Environmental Toxicology, Taylor & Francis Ltd., 2000.

Course Outcomes:

At the end of the course student will be able to

1. Understand the environmental issues related with engineering products and processes.
2. Understand and apply the concept of design for environment to industrial products and processes.
3. Summarize various techniques for cleaner production and to apply environmentally sustainable management concepts in industries.
4. Carry our life cycle analysis, and apply ISO Environmental Management Standards.

CEOE411 Advanced Concrete Technology

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course:
The course covers the properties of ingredients of concrete, concrete design mix, behaviour of concrete at its fresh and hardened state, procedures in concreting and special concrete and their use.

Course Content:
Unit-I (10 hrs)
Introduction -Concrete materials –Cement – Types, Physical tests on cement - Aggregates types, Tests on aggregates - Quality of Water for mixing and curing - Mineral and chemical Admixtures. Concrete Manufacturing: Batching -Mixing -Transportation -Placing of concrete -curing of Concrete. Fresh and hardened properties of Concrete.
Unit-II (7 hrs)
Mix Design -factors influencing mix proportion -Mix design by ACI method and IS code method. Design of normal concrete, high strength concrete and self compacting concrete.
Unit-III (10 hrs)
Creep, Shrinkage and temperature effects of concrete -durability of concrete: deterioration under chemical attacks and freeze and thaw attack -permeability of concrete –Corrosion of rebar - Causes and effects -remedial measures, Fire resistance of concrete, Rebound hammer and Ultra-sonic pulse velocity testing methods, microstructure of concrete.
Unit-IV (9 hrs)
Special Concrete –Lightweight concrete - High Density Concrete - Hot and Cold weathering Concrete -Fibre reinforced concrete -Polymer concrete -Ferro cement -Ready mix concrete-High Performance Concrete -Self compacting concrete (Principles, Ingredients used, Production, Curing, Mechanism, Properties, Durability etc.), Sustainability of concrete.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Mehta P. K. and Monterio P. J. M. (2017), Concrete: Microstructure, Properties, and Materials, 4th edition, McGraw Hill Education, USA.
2. Shetty, M.S., Concrete Technology (Theory & Practice), S. Chand and Co, Revised edition, 2015.
3. Gambhir, M.L., Concrete Technology, Tata McGraw Hill, fifth edition, 2013.
4. A. M. Neville, Properties of Concrete, Pearson India, fifth edition.
5. IS 456 (2000), Plain and Reinforced Concrete - Code of Practice, Bureau of Indian Standards (BIS), New Delhi, India.
6. IS 10262 (2019), Concrete Mix Proportioning – Guidelines, Bureau of Indian Standards (BIS), New Delhi, India.
7. ACI 318 (2014), Building code requirements for structural concrete (ACI 318-2014) and Commentary (ACI 318R-2014). American Concrete Institute, Detroit, MI, USA.

Course Outcomes:

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

CO1 Test all the concrete materials as per IS code.

CO2 Design the concrete mix using ACI and IS code methods.

CO3 Determine the properties of fresh and hardened of concrete.

CO4 Ensure quality control while testing/ sampling and acceptance criteria.

CO5 Design special concretes and their specific applications.

CEOE412 Transportation Planning

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: Transportation planning is the process of defining future policies, goals, investments, and spatial planning designs to prepare for future needs to move people and goods to destinations. As practiced today, it is a collaborative process that incorporates the input of many stakeholders including various government agencies, the public and private businesses. Transportation planners apply a multi-modal and/or comprehensive approach to analyzing the wide range of alternatives and impacts on the transportation system to influence beneficial outcomes.

Course Content:

Unit-I 10 hrs

1. Transport Planning Process

Status of transportation in India. Objectives and scope of transport planning. Urban, regional and national transport planning. Transport planning process, various stages. Land use and traffic.

2. Transportation Survey

Definition of study area. Zoning. Types of surveys. O-D surveys. Inventories of existing transport facilities, land use and economic activities.

Unit-II 10 hrs

3. Trip Generation

Trip purpose. Factors affecting trip generation. Trip generation estimation by multiple linear regression analysis, brief review of category analysis, advantages and limitations of these methods.

4. Trip Distribution

Methods of trip distribution. Basic concepts of uniform factor method, average factor method and opportunity model. Trip distribution by gravity model.

Unit-III 8 hrs

5. Traffic Assignment

Principles of assignment. Assignment techniques. All or nothing assignment. Brief review of multipath assignment, capacity restraint assignment and diversion curves.

6. Modal Split

General considerations for modal split. Factors affecting modal split. Brief introduction to various methods of modal split.

Unit-IV 8 hrs

7. Evaluation

Need for evaluation. Several plans to be formulated. Testing. Considerations in evaluation. Economic evaluation, basic principles, brief introduction to various methods of economic evaluation, comparison.

8. Mass Rapid Transit Systems

Problems of Urban Transport. Introduction to MRTS. Requirements of MRTS. Types of MRTS. MRTS in India. MRTS Corridor selection

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Traffic Engg. and Transport Planning by L. R. Kadiyali, Khanna Publishers, Delhi.
2. Highway Engg by S. K. Khanna & C.E.G. Justo, Nem Chand Bros., Roorkee.
3. Introduction to Transport Planning by Bruton, M.J., Hutchinson Technical Education, London.
4. Principles of Transportation Engg, P. Chakroborty & Animesh Dass, Prentice Hall of India, 2003.

Course Outcomes:

On completion of the course, the students shall be able to:

1. Gain Engineering knowledge of the subject and apply it for the solution of problems related to urbanisation
2. Make investigations, use modern tools, forecast travel demand and develop solutions to cater to increased future traffic.
3. Understand the engineering solutions in societal and environmental context for sustainable development that takes care of optimal use of resources.
4. Understand the norms of engineering practice and the need for life-long learning as per their exposure to relevant latest know-how in the field of planning.

Syllabi of additional courses for minor degree in Civil Engineering (Geoinformatics)

CEPC501 Fundamentals of Remote Sensing

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This course has been designed to introduce students the concepts of remote sensing processes and components, and the elements of data interpretation, and to expose them to the various remote sensing platforms and sensors.

Unit 1 Remote Sensing & Electromagnetic Radiation 9 hrs

Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – wave theory, particle theory, Stefan – Boltzmann Law and Wien's Law – visible and non-visible spectrum – Radiation sources: active & passive; Radiation Quantities
radiation with atmosphere - Scattering (Rayleigh, Mie, non-selective scattering) absorption and refraction – Atmospheric effects on visible, infrared, thermal and microwave spectrum – Atmospheric windows.

Unit 2 EMR Interaction with Atmosphere and Earth 9 hrs

Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere - Scattering (Rayleigh, Mie, non-selective scattering) absorption and refraction – Atmospheric effects on visible, infrared, thermal and microwave spectrum – Atmospheric windows.
Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer / Spectrophotometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water body – Factors affecting spectral reflectance of vegetation, soil and water body.

Unit 3 Platforms, Sensors and Data 9 hrs

Ground based platforms –Airborne platforms – Space borne platforms – Classification of satellites
– Sun synchronous and Geosynchronous satellites – Resolution concepts – Scanners - Along and across track scanners – Orbital and sensor characteristics of different satellites – Airborne and Space borne TIR sensors – Calibration – S/N ratio – Passive/Active microwave sensing – Airborne and satellite borne RADAR –SAR –LIDAR, UAV – High Resolution Sensors

Unit 4 Remote Sensing Image Interpretation 9 hrs

Photographic (film and paper) and digital products – quick look products - High Resolution data products data – ordering, interpretation – basic characteristics of image elements – interpretation keys (selective and elimination) – visual interpretation of natural resources.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Richards, Remote sensing digital Image Analysis-An Introduction Springer - Verlag 1993.
2. Lillesand, T.M. and Kiefer R.W. Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York, 2002.
3. Janza, F.Z., Blue H.M. and Johnson, J.E. Manual of Remote Sensing. Vol. I, American Society of Photogrammetry, Virginia, USA, 2002.
4. Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995.
5. Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 2003.

Course Outcomes:

On completion of the course, the students shall be able to understand:

1. the characteristics of electromagnetic radiation and its interaction with earth features.
2. the types and configuration of various satellites and sensors.
3. the elements of data interpretation.

CEPE501 Cartography and Basic of GIS

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This course has been designed to introduce students the concepts of Cartography and GIS, GIS data structures, data input and data presentation and to expose them to the process of map making and production.

Unit 1 Elements of Cartography **6 hrs**

Definition of Cartography - Maps - functions - uses — Types of Maps – Map Scales and Contents – Map projections – shape, distance, area and direction properties – perspective and mathematical projections – Indian maps and projections – Map co-ordinate systems – UTM and UPS references

Unit 2 Map Design and Production **6 hrs**

Elements of a map - Map Layout principles – Map Design fundamentals – symbols and conventional signs - graded and ungraded symbols - color theory - colours and patterns in symbolization – map lettering - map production – map printing– colours and visualization – map reproduction - Map generalization - geometric transformations – bilinear and affine transformations

Unit 3 Fundamentals of GIS **12 hrs**

Introduction to GIS - Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.

Unit 4 Data Quality, Input, Topology **12 hrs**

Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards – Interoperability - OGC - Spatial Data Infrastructure - -Data Output - Map Compilation – Chart/Graphs

Datum Projection and reprojection -Coordinate Transformation – Topology -Adjacency, connectivity and containment – Topological Consistency – Non topological file formats Attribute Data linking – Linking External Databases – GPS Data Integration - Raster to Vector and Vector to Raster Conversion

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. Arthur, H. Robinson, “Elements of Cartography”, Seventh Edition, John Wiley and Sons, 2004.
2. Kang-Tsung Chang, “Introduction to Geographic Information Systems", McGraw-Hill Publishing, 2nd Edition, 2011.

3. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, “An Introduction to Geographical Information Systems, Pearson Education, 2nd Edition, 2007.
4. John Campbell, " introductory Cartography", Wm. C. Brown Publishers, 3rd Edition, 2004.
5. C.P. Lo Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice Hall of India Publishers, 2006.

Course Outcomes:

On completion of the course, the students shall:

1. be familiar with appropriate map projection and co-ordinate system for production of: maps and shall be able to compile and design maps for the required purpose.
2. be familiar with co-ordinate and datum transformations.
3. understand the basic concepts and components of GIS, the techniques used for storage of spatial data and data compression.
4. understand the concepts of spatial data quality and data standard.

CEPE502 Digital Image Processing

Pre-requisite: None

L	T	P/D	Credits	Total contact hours
3	0	0	3	3

Brief description of the course: This course has been designed to make the undergraduate engineering students understand the concepts, principles, processing of satellite data in order to extract useful information from them.

Unit 1: Introduction **6 hrs**

Image processing system considerations. Initial statistical extraction – univariate and multivariate statistics, histogram and its significance in remote sensing data. Preprocessing-Radiometric corrections and Geometric Corrections of Remote Sensing Data

Unit 2: Image Enhancements **8 hrs**

Image Reduction & Magnification, Transects, contrast enhancement: linear, non-linear, Spatial Filtering: Spatial Convolution filtering, Image transform – Arithmetic operations'-based image transforms, principal component analysis, Tasseled cap transformation, Fourier transforms, Fast Fourier frequency domain filters

Unit 3: Image segmentation **6 hrs**

Points, lines and edge detection and combined detection. Thresholding: The Basics of Intensity Thresholding, The Role of Noise, The Role of Illumination and Reflectance, Basic Global Thresholding, Split and merge Segmentation

Unit 4: Thematic information extraction **8 hrs**

Pattern recognition: Supervised Classification: Select the Appropriate Classification Algorithm Unsupervised Classification, Fuzzy Classification, Object - Based Image Analysis (OBIA) Classification, Classification Based on Machine Learning and deep learning algorithms.

Unit 5: Change detection **8 hrs**

Steps Required to Perform Change Detection, Binary Change Detection Algorithms Provide Change/No-Change Information. Interpretation of Hyperspectral Image Data – Data Characteristics, Challenges to Data Interpretation, Data Calibration Techniques, Interpretation using Spectral Information, Hyperspectral Interpretation by Statistical Methods, Feature Reduction.

Note: The focus of concluding lectures should be to emphasize the value addition of the subject and also on how it impacts the environment. Further, the faculty may suggest possible sustainable solutions/emerging technologies/innovations towards sustainability in the subject domain.

Text Books/Reference:

1. John, R. Jensen, Introductory Digital Image Processing – Prentice-Hall, New Jersey, 1986.
2. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 3rd ed, Pearson Int. Ed.

3. Paul M. Mather, Magaly Koch, Computer Processing of Remotely-Sensed Images: An Introduction, 2010, John Wiley & Sons, Ltd.
4. John A. Richards, Xiuping Jia, Remote Sensing Digital Image Analysis: An Introduction, Published by Springer, 1999.

Course Outcomes:

On completion of the course, the student will be able to understand

1. various components and characteristics of image processing systems.
2. the concepts of image geometry and radiometry and corrections.
3. various types of image enhancement techniques used for satellite image processing.