DEPARTMENT OF CIVIL ENGINEERING

Course Structure and Syllabi

for

UG Course of Civil Engineering
(Effective from AY 2020-2021)

INDIAN INSTITUTE OF TECHNOLOGY (ISM), DHANBAD

Dhanbad-826004, Jharkhand
September 2019

COURSE STRUCTURE

Semester III

S. No.	Course type	Subject Code	Subject Name	Lecture (L)	Tutorial (T)	Practical (P)	Credit Hours	Contact Hours
1	DC1	**CEC201**	Surveying	3	0	0	9	3
2	DC2	**CEC202**	Environmental Engineering	3	0	0	9	3
3	DC3	**CEC203**	Building Materials, Construction and Management	3	0	2	11	5
4	E/SO1	**CEE201**	Mechanics of Solid	3	0	0	9	3
5	E/SO2		***E/SO 2***	3	0	0	9	3
6	DP1	**CEC204**	Material Testing Laboratory	0	0	2	2	2
7	DP2	**CEC205**	Environmental Engineering Laboratory	0	0	2	2	2
						Total Credit	**51**	21

Semester IV

S. No.	Course type	Subject ID	Subject Name	Lecture (L)	Tutorial (T)	Practical (P)	Credit Hours	Contact Hours
1	E/SO3	**CEE202**	Fluid Mechanics and Machines	3	0	0	9	3
2	DC4	**CEC206**	Structural Analysis-I	3	1	0	11	4
3	DC5	**CEC207**	Design of Concrete Structures	3	0	0	9	3
4	DC6	**CEC208**	Geotechnical Engineering	3	0	0	9	3
5	DC7	**CEC209**	Transportation Engineering	3	1	0	11	4
6	DP3	**CEC210**	Surveying Laboratory	0	0	2	2	2
7	DP4	**CEC211**	Transportation Engineering Laboratory	0	0	2	2	2
						Total Credit	**53**	21

Semester V

S. No.	Course type	Subject ID	Subject Name	Lecture (L)	Tutorial (T)	Practical (P)	Credit Hours	Contact Hours
1	DC8	**CEC301**	Structural Analysis-II	3	0	0	9	3
2	DC9	**CEC302**	Foundation Engineering	3	0	0	9	3
3	OE1		***Open Elective 1:***	3	0	0	9	3
4	HSS1		***HSS***	3	0	0	9	3
5	E/SO4		***E/SO 4***	3	0	0	9	3
6	DP5	**CEC303**	Structural Engineering Laboratory	0	0	2	2	2
7	DP6	**CEC304**	Geotechnical Engineering Laboratory	0	0	2	2	2
				Total Credit			**49**	19

Semester VI

S. No.		Subject ID	Subject Name	Lecture (L)	Tutorial (T)	Practical (P)	Credit Hours	Contact Hours
1	DC10	**CEC305**	Design of Steel Structures	3	0	0	9	3
2	DC11	**CEC306**	Water Resources Engineering	3	0	0	9	3
3	MS1		***MS***	3	0	0	9	3
4	OE2		***Open Elective 2:***	3	0	0	9	3
5	OE3		***Open Elective 3:***	3	0	0	9	3
6	DP7	**CEC307**	Structural Detailing Laboratory	0	0	2	2	2
7	DP8	**CEC308**	Water Resources Engineering Laboratory	0	0	2	2	2
				Total Credit			**49**	19

Semester VII

S. No.		Subject ID	Subject Name	Lecture (L)	Tutorial (T)	Practical (P)	Credit Hours	Contact Hours
2	DE1	**CED401**	Traffic Engineering and Management	3	0	0	9	3
3	DE2	**CED402**	Advanced Design of Structures	3	0	0	9	3
	OE4		***Open Elective 4:***	3	0	0	9	3
4	OE5		***Open Elective 5:***	3	0	0	9	3
5	OE6		***Open Elective 6***:	3	0	0	9	3
6	DC12*	**CES401**	Internship/Training/Seminar/Field-Excursion	0	0	0	S/X	0
7	DC13*	**CES402**	UGP-1 (Zero-Credit Compulsory)	0	0	0	6	0*
				Total Credit			**51**	15

Semester VIII

S. No.		Subject ID	Subject Name	Lecture (L)	Tutorial (T)	Practical (P)	Credit Hours	Contact Hours
1	DE3	**CED403**	Advanced Hydrology	3	0	0	9	3
2	DE4	**CED404**	Environmental Engineering II	3	0	0	9	3
3	OE7		***Open Elective 7***:	3	0	0	9	3
4	OE8/HSS3		***Open Elective 8***:	3	0	0	9	3
5	DC14*	**CES403**	UGP-2 (Zero-Credit Compulsory)	0	0	0	6	0*
				Total Credit			**42**	12

**Internship and Project shall start after the VI Semester, from Summer months and Viva–Voce for the internship shall be held at the beginning of the VIII Semester, while the project will continue up to the end of the VIII Semester.*

NOTE:1. OE allotment to be based on CGPA up to previous semester, Total strength of students to be decided by the Dept/Teacher concerned.

2. In place of practicals, a few courses with tutorials can be offered by the Department.

Credit Requirement for the 4-Year B.Tech. Programme

Course Component	**Course Credits**	**~% of Total Credits**	**Final credit hours**
Institute Core (IC)	109	27-28	109
Department Core (DC)	124-133	32-33	133 (11×9 +2(T)+ 2(P)) +(2×8 Lab) +(12 Project)
Department Elective (DE)	36-45	9-11	36(4×9)
Engineering/Science Option (E/SO)	36	9	36(4×9)
Open Elective (OE)	63	15-16	72 (8×9)
HSS+MS	9+9=18	4.5	18(2×9)
Total	**386-404**	**100**	**404**

Course Type	Course Code	Name of Course	L	T	P	Credit
DC 1	CEC 201	**Surveying**	3	0	0	9

Course Objective
The course deals with the basics of surveying and levelling, concepts of total station and provides knowledge on Photogrammetry and GPS surveying.
Learning Outcomes
After studying this course, students should be able to: ● Understand the fundamental principles of surveying and levelling. ● An in-depth knowledge of triangulation, curves and total station survey. ● Understand various applications, concepts of photogrammetry and get acquainted with GPS surveying.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	**Surveying:** Definition, Classification, Principles, Accuracy and Errors. **Measurements**: Linear measurements by chain and tape, Angular measurements by compass and theodolite. **Traversing:** Introduction, Methods of traversing, Plotting traverse survey, Latitude and Departure. **Levelling:** Types of levels, Principle of levelling, Methods of levelling, Differential levelling, Fly levelling, Curvature and Refraction, Contouring.	**18**	Understanding the basic principles of surveying and studying various methods for horizontal and vertical measurements.
2	**Triangulation:** Classification, Strength of the figure, criteria for selection, Towers and signals, Base line measurement, Satellite station. **Curves:** Introduction, Classification, Simple, Compound and Vertical curves. **Total Station:** Principle of electronic measurement of distance and angles, Features of total station, Setting-up and orienting a total station, Digital Plans.	**11**	In-depth knowledge of triangulation for establishing accurate ground control points, curves for various purposes. Knowledge on concept of total station survey.
3	**Applications:** Measurement of area and volume, Applications and Recent developments in surveying. **Aerial Survey:** Photogrammetry - Basic principles, Aerial and terrestrial, Flying height and scale, Flight planning for aerial photography, Photo- interpretation, Applications of photogrammetry. **GPS surveying:** Introduction, Principle, GPS receiver, Differential GPS, GPS surveying techniques, IRNSS- NAVIC, Mapping with GPS.	**10**	Understanding the area and volume measurement, applications and recent developments. Knowledge on advanced surveying techniques in terms of Photogrammetry and GPS surveying.

Text Books:

1. Chandra, A.M. (2012). Plane Surveying, 2nd Edition, New Age International (P) Ltd. New Delhi.
2. Chandra, A.M. (2015). Higher Surveying, 3rd Edition, New Age International (P) Ltd. New Delhi.
3. Duggal, S. K. (2017). Surveying: Volume - 1 & 2, 4th Edition, McGraw Hill Education (India). Pvt. Ltd., Chennai.
4. Anderson, J.M. and Mikhail, E.M. (1997). Surveying: Theory and Practice, 7th Edition, McGraw-Hill Education.

Reference Books:

1. Arora, K.R. (2015). Surveying: Volume - 1,2 and 3, 17th Edition, Standard Book House, New Delhi.
2. Hofmann-Wellenhof, B., Lichtenegger, H. and Collins J.(2001). GPS: Theory and Practice, Springer.
3. Wolf P.R. (2013). Elements of Photogrammetry, Mc Graw Hill India.

Course Type	Course Code	Name of the course	L	T	P	Credit
DC 2	**CEC202**	**Environmental Engineering**	3	0	0	9

Course Objective

This course is to provide an understanding on water chemistry, principles of water treatment processes and to comprehend the essential concepts of air, noise pollution and solid waste management.

Learning Outcomes

After studying this course, students should be able to:

- Get an insight into the structure of drinking water supply systems, water collection, water purification and water supply scheme.
- Understand the basics of sewage treatment and solid waste management systems.
- Understand the fundamental aspects of air and noise pollution

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	Overview of Water Works- Sources, Water quality and drinking water standards, Demand, factors affecting water demand, variations in water demand. Design periods and design population, design capacities for various water supply components,	**7**	Understand the fundamental principles of design of water supply systems.
2	Physical, chemical and biological analysis of water, Overview of water treatment processes, Screening, Principles of Sedimentation, Coagulation and Flocculation, Introduction to filtration system, Types of filters and their classification, filter components, Basics of Disinfection, Water softening and Miscellaneous treatment systems	**15**	An in-depth knowledge of various unit operations for the water treatment.
3	Introduction to Sewage Collection and Disposal System- Components and Layout, Sludge Disposal	**5**	To provide a basic understanding on sewage disposal system
4	Basics of Solid Waste Management: Sources of Solid waste, Classification, Engineered systems for collection, recycling and reuse of solid waste Introduction to air pollution, Classification of air pollutant, Atmospheric meteorology, Prediction of pollutant concentration, Control methods for particulate and gaseous pollutant. Introduction to noise pollution, effect of noise pollution, levels of noise, noise rating system and noise abatement and control.	**9**	To gain an understanding of solid waste management systems, air pollution and noise pollution.
5	Overview and design of Distribution Systems, Layouts of distribution network, Methods of Distribution	3	Understand the design of water distribution systems.

Recommended Text Books:

1. Environmental Engineering (2013 ed.)-Peavy and Rowe, McGraw Hill India.
2. Environmental Engineering-II, S K Garg, Khanna Publishers, India

Recommended References

1. Environmental Engineering-I, (33rd ed.)- S K Garg, Khanna Publishers, Delhi.
2. Theory and practice of water and wastewater treatment (2009)-Textbook by Ronald L. Droste, Willey

Course Type	Course Code	Name of Course	L	T	P	Credit
DC 3	CEC203	**Building Materials, Construction and Management**	3	0	2	11

Course Objective
The objective of the course is to understand the properties, behaviour and the use of suitable construction materials, building estimation and management.
Learning Outcomes
Upon successful completion of this course, students will: ● Understand the basic properties, select suitable materials for buildings, ● Adopt suitable construction techniques, ● Estimation and management.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	**Construction Materials:** Introduction; Cement: Composition and properties, Aggregate: Classification and Characteristics; Concrete: Classification, Production, Proportioning and Mix Design, Quality control, Mechanical and durability properties, Destructive and Non-destructive tests; Mortar: Classification and Characteristics; Ferrous Metals: Types of steel and Civil engineering application.	16	Understanding the basic properties and select the suitable building materials for different construction purposes.
2	**Building Construction /Techniques:** Foundations: Function and Classifications; Brick Masonry; Wall, Doors and Windows; Stairs; Floors; Roofs; Lintels and Arches; Plastering and Painting; Formwork.	10	Understand the different construction procedures and techniques.
3	**Estimation and Costing:** Introduction; Methods of estimation; Estimation of Buildings; Schedule of rates; Rate analysis	3	Able to estimate the building structures and perform rate analysis.
4	**Construction Planning and Management:** Critical path method (CPM); Programme evaluation and review technique (PERT) - Network techniques breakdown structures, classification of activities, rules for developing networks, network development, network analysis, critical activities and critical path - Cost optimization, Usage of different construction equipment	10	Gain exposure to construction planning and management.

Text Books:

1. Varghese, P.C., (2015). Building Materials, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi.
2. Arrora, S.P. and Bindra, S.P. The Text Book of Building Construction, Dhanpat Rai Publishing Co Pvt Ltd
3. Dutta, B.N., Estimation and Costing, UBS Publishers' Distributors Ltd.
4. Patrick, C. (2012). Construction Project Planning and Scheduling, Pearson Education India.

Reference Books:

1. Neville, A.M. and Brooks, J.J. (2010). Concrete Technology, 2nd Edition, Prentice Hall, Pearson Education.
2. Gambhir, M.L. and Jamwal, N. (2014). Building and Construction Materials: Testing and Quality Control, McGraw Hill Education (India) Pvt. Ltd., New Delhi.

Course Type	Course Code	Name of the course	L	T	P	Credit
ESO 1	CEE201	**Mechanics of Solids**	3	0	0	9

Course Objective
This course deals with the study of the effects of forces and moments on the deformation of a solid body.
Learning Outcomes
After studying this course, students should be able to: ● Understand the fundamental principles of stresses and strains and deformations of solids. ● An in-depth knowledge of shear force and bending moment diagrams, and different stresses in a loaded element ● To know the torsional effect on a structural element and to know the stresses in thin and thick walled structures ● Understand the stability of a strut and to know the stresses due to unsymmetrical loading.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	Stress strain behavior of engineering materials, Concept of stress and strain field, stress tensor, stress-strain transformation, stress invariants, Temperature Stress and Strain, Mohr's Circle for plane stress and plane strain, Relations between Elastic Constants, Hooke's law and compatibility conditions, differential equation of equilibrium. Different theories of failure.	**11**	Understand the fundamental principles of stresses and strains and deformations of solids.
2	Shear Force and Bending Moment Diagrams, Energy methods, Bending analysis, Composite section analysis, Combined Bending and Direct Stresses, Shear Stress Distributions.	**10**	An in-depth knowledge of shear force and bending moment diagrams, and different stresses in a loaded element
3	Torsion of circular members and thin walled tubes, Introduction to torsion of bars with non-circular sections. Analysis of thick and thin cylinders, compound cylinders	**8**	To know the torsional effect on a structural element and to know the stresses in thin and thick walled structures
4	Elastic stability of columns, Euler's Buckling load, Close and Open-Coiled Helical Springs, Unsymmetrical Bending and Shear Centre.	**10**	Understand the stability of a strut and to know the stresses due to unsymmetrical loading.

Recommended Text Books:

1. R.C. Hibbeler. Mechanics of Materials, Pearson India Education Services Pvt. Ltd
2. F.P. Beer, E.R. Johnston, J.T. DeWolf, D.F. Mazurek. Mechanics of Materials, Tata McGraw-Hill Publishing Company Limited.

Recommended References:

3. J.M. Gere and B.J. Goodno. Mechanics of Materials, Cengage Learning.
4. S. Timoshenko. Strength of Materials, Part 1 and Part 2, CBS Publishers & Distributors.

Course Type	Course Code	Name of Course	L	T	P	Credit
DP1	CEC204	Material Testing Laboratory	0	0	2	2

Course Objective
The objective of the course is to conduct various tests and evaluate the engineering characteristics of building/construction materials by laboratory procedures.
Learning Outcomes
Upon successful completion of this laboratory, students will: ● Be able to perform the laboratory tests on different construction materials ● Able to compute and analyze the results of the respective laboratory tests

Experiment No.	Experiments to be Covered	Laboratory	Learning Outcome
1	**Water content and Specific Gravity of Soil:** Oven dry, and Infrared method; Specific gravity by density bottle.	1	Water content and specific gravity determination of soils.
2	**Particle Size Analysis of Soil:** Dry sieve analysis, and Hydrometer analysis	1	Grain size distribution of given soil samples.
3	**Tests on Cement:** Specific gravity, Fineness, Consistency, Initial setting time, Final setting time and Soundness of cement	1	Tests on basic properties of cement
4	**Strength of Cement and Concrete:** Compressive strength of cement, Compressive strength of concrete, and Split tensile strength of concrete	1	Strength properties of cement and concrete.
5	**Workability of Concrete:** Slump Cone test, Compaction factor/Vee-Bee consistometer tests	1	Evaluate the workability of given concrete.
6	**NDT of Structures:** Non-destructive testing of concrete/structures by rebound hammer, etc	1	Perform the non-destructive testing on concrete structures
7	**Tests on Aggregates:** Specific gravity of fine and coarse aggregates	1	Determine the specific gravity of fine and coarse aggregates.
8	**Tests on Aggregates:** Bulking of fine aggregate, Fineness modulus of fine and coarse aggregates	1	Bulking and fineness modulus of fine and coarse aggregates
9	**Tests on Bricks:** Compressive strength of bricks, and Water absorption of bricks	1	Strength and water absorption of bricks
10	**Project, Revision and Evaluation**	4	Project on testing of materials

Text Books/References:

1. Respective Bureau of Indian Standard/ International Standard Codes of Practices.
2. Bowles, J.E. (2012). Engineering Properties of Soil and their Measurement, 4th Edition, McGraw Hill (India) Publishers.
3. Purushothama, R. (2017). Testing Methods for Civil Engineering Materials, New Age International Publishers.

Course Type	Course Code	Name of the course	L	T	P	Credit
DP 2	CEC205	**Environmental Engineering Laboratory**	0	0	2	2

Course Objective

The subject offers the readers a fundamental understanding of the water quality parameters and its role in environmental engineering.
To describe methods of advanced effluent treatment for higher discharge standards and effluent re-use.

Learning Outcomes

After studying this course, students should be able to:

- Understand the water quality parameters and the significance.
- Understanding the operational condition during project work.

Expt No.	Topics to be Covered	Laboratory	Learning Outcome
1	Calibration of pH meter, TDS and conductivity meter and determination of pH, TDS and conductivity of a given water sample.	**1**	Understand the water quality parameters and the significance. Understanding the operational condition during project work. .
2	Determination of Turbidity and Sulphate in given water sample	**1**	
3	Determination of acidity and alkalinity of given water sample.	**1**	
4	Determination of hardness, chloride of given water sample.	**1**	
5	Determination of optimum coagulant dose using jar test.	**1**	
6	Determination of optimum lime soda dose for hardness removal	**1**	
7	Determine DO, BOD and COD and biodegradability index of a given wastewater Sample.	**1**	
8	Determine the ammonical nitrogen and TKN concentration in the given wastewater samples.	**1**	
9	Determine TS, TSS, VSS and FS in the given sludge samples.	**1**	
10	Determine the oil and grease content in given wastewater samples.	**1**	
11	Determine the CNP ratio in the given wastewater sample.	**1**	
12	Determine the MLVSS, MLSS, SVI and VSS/SS ratio of a given sludge sample.	**2**	

Text Books/References:

1. Relevant Indian and International Standard code of practice.
2. Manual for Environmental Engineering Laboratory

Course Type	Course Code	Name of Course	L	T	P	Credit
ESO 2	CEE202	Fluid Mechanics and Machines	3	0	0	9

Course Objective

This course deals with the basic concepts of fluid mechanics and machines for engineering applications.

Learning Outcomes

Upon successful completion of this course, students will be able:

- To understand the properties and behaviour of different types of fluids.
- To apply the concepts of conservation of mass, momentum and energy for solving fluid flow problems.
- To understand the working principle of common fluid machines, particularly hydraulic machines.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	**Fundamental Concepts:** Introduction, Properties of fluid, Newtonian and non-Newtonian fluids. **Fluid Statics:** Pascal's law, pressure variation in a static fluid, hydrostatic forces on plane and curved surfaces, buoyancy, conditions of equilibrium.	**6**	Understand the concepts required to analyse fluids. Knowledge to analyse and measure the pressure acting on fluid at rest.
2	**Fluid Kinematics:** Classification of fluid flow, methods of describing fluid motion, discharge, continuity equation, flow net, vorticity. **Fluid Dynamics:** Forces acting on fluid in motion, Euler's equation, Bernoulli's theorem and applications – venturi meter, orificemeter, pitot tube.	**8**	To know the concepts required to analyse the fluid motion and the forces associated with it. Knowledge about the methods of flow measurement in pipes.
3	**Dimensional Analysis and Model Studies:** Dimensional analysis - Rayleigh's method, Buckingham's Π- theorem method, model & prototype, model studies – similarity types, model laws **Laminar Flow:** Hagen-Poiseuille equation for flow through a circular pipe, Darcy's law. **Turbulent Flow:** Variation of turbulent fluctuations, Prandtl's mixing length theory**.** **Flow through Pipes:** Reynolds experiment, loss of energy in pipes, Darcy - Weisbach equation for loss of head in pipes, flow through pipes in series, flow through parallel pipes**.**	**11**	Understanding the methodology for application of the dimensional analysis and model study to understand and solve complex problems associated with fluid flow. To know the various types of flows in pipes. An overview of different flow conditions in pipes.
4	**Impact of Jet:** Impulse- momentum principle, impact of jet on stationary and moving flat surfaces and curved surfaces. **Hydraulic Turbines:** Types, Pelton, Francis and Kaplan turbines. **Hydraulic Pumps:** Types, Centrifugal pump, Reciprocating pump, single acting and double acting reciprocating pump.	**14**	Understanding the applications of impact of jet on stationary and moving surfaces. To know the working principle of turbines and pumps.

Text Books:

1. Som, S.K., Gautam Biswas and Suman Chakraborty (2012). Introduction to Fluid Mechanics and Fluid Machines, 3rd Edition, Tata McGraw Hill Edu. Pvt. Ltd., India.
2. Ojha,C.S.P., Berndtsson, R. and Chandramouli, P.N. (2010). Fluid Mechanics and Machinery, 1st Edition, Oxford University Press, India.

Reference Books:

1. Cengel, Y.A. and Cimbala, J.M. (2014), Fluid Mechanics, 3rd Edition, McGraw Hill Education Pvt. Ltd., India.
2. Fox, R.W. and McDonald, A.T. (2016), Fluid Mechanics, 9th Edition, Wiley, India.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC 4	CEC206	**Structural Analysis-I**	3	1	0	11

Course Objective
The main focus of this course is analysis of determinate structures. The problem type consists of beam, truss and frame structures. Basic idea about indeterminate structure will also be emphasized.
Learning Outcomes
After studying this course, students should be able to: ● Analyse various determinate structures. ● Calculate deflection of different structures. ● Acquire basic knowledge about indeterminate structures

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	**Introduction:** Revisit to estimation of support reactions and plotting SFD and BMD, Loading and modelling, Internal forces in statically determinate structures- plane and space trusses, beams, frames, simple, compound and complex trusses.	4	Introduction to methods and expected outcome of structural analysis
2	**Deflection by Elastic beam theory**: Double Integration Method, Conjugate beam and area moment theorems.	7	Estimation of deflection of determinate beams by elastic beam theory, advantages and limitations of these methods
3	**Strain energy method for slopes and deflections**: Introduction to strain energy method, Unit load method, Castigliano's Theorem, Deflection due to shear, torsion, temperature and fabrication error.	8	Idea of virtual load and virtual work, Calculating deflections of a statically determinate structure at point of application of load or at other points.
4	**Cables and Arches**: Analysis of cables and two hinged suspension bridges, Analysis of three hinged arches, Analysis of two hinged and fixed arches	6	Analysis of tension-based cables and compression-based arches
5	**Introduction to Indeterminate structures**: Static and kinematic indeterminacies, methods of analysis, Theory of least work, Consistent deformation method	7	Understanding stability and determinacy of structures, application of theorem of least work and Maxwell-Betti's reciprocal theorem, Understanding advantages and limitation of force based methods
6	**Plastic Analysis:** Shape factor, Plastic hinge, Methods of Plastic Analysis: Upper-bound and lower-bound theorems, Analysis of beams and frames.	7	Introduction to material and cross section behaviour beyond the elastic limit, Understanding the basis of plastic design and ultimate design.

Recommended Text Books:

1. Hibbeller, R. C., "Structural Analysis", 6th Edition, Pearson Education.

Recommended References:

1. Timoshenko, S.P., and Young, D.H., "Theory of Structures", McGraw Hill International Edition.
2. Utku,S., Norris,C.H. and J.B. Wilbur., "Elementary Structural Analysis", McGraw Hill Book Company.
3. Reddy, C. S., "Basic Structural Analysis", Tata McGraw Hill Publishing.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC 5	CEC207	**Design of Concrete Structures**	3	0	0	9

Course Objective
This course deals with the contemporary professional aspects in the analysis, design and construction of Concrete Structures along with the basic understanding of fundamental concepts.
Learning Outcomes
After studying this course, students should be able to: ● Understand the basic concept and behaviour of Concrete Structures. ● Develop knowledge and skill to analyze and design various structural concrete members.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	Introduction, Materials, Loadings, Structural forms, Structural Integrity, Design Methodologies: Working stress and Limit state methods, Design codes	**3**	Understand the fundamental principles of materials, loading and design methodologies.
2	RC members under flexure, Analysis and Design of singly and doubly reinforced sections; rectangular and flanged sections, Flexural ductility, Design for shear, torsion, bond and anchorage, Development length, Deflection and Crack Width	**11**	Acquire knowledge on design principles of flexural members, shear and torsion design, bond behaviour and serviceability limit states.
3	Types of slabs, One way and Two-way slabs, Type of Staircases, Design of Staircases	**8**	Familiar with various types of slabs and their design considerations, design of staircases.
4	Compression member: Short columns under axial compression, Short columns under axial compression with uni-axial bending, Short columns under axial compression with bi-axial bending, slender columns	**8**	In-depth knowledge in the design of short and slender columns subjected to axial load as well as combined axial load and bending moment.
5	Types of footings; Design of footings, combined footings, Retaining walls	**10**	Comprehend the design of footings and retaining walls.

Recommended Text Books:

1. Reinforced Concrete: Limit State Design; A. K. Jain; Nem Chand & Bros.
2. Reinforced Concrete Design; D. Menon and S. Pillai; Tata McGraw Hill

Recommended References:

1. Limit State Design of Reinforced Concrete; P.C. Varghese; PHI Learning Pvt. Ltd.
2. Design of Reinforced Concrete Structures; N. Subramanian; Oxford University Press.
3. Reinforced Concrete Structures; R. Park and T. Paulay; John Wiley & Sons

Course Type	Course Code	Name of Course	L	T	P	Credit
DC 6	CEC208	Geotechnical Engineering	3	0	0	9

Course Objective
The main focus of the course is to develop a thorough understanding of the basics of soil behaviour and the mechanics involved for designing of geotechnical systems.
Learning Outcomes
Upon successful completion of this course, students will be able to: ● Comprehend the soil as three-phase materials ● Understand various engineering parameters of soil ● Acquire a basic understanding of soil mechanics required for designing of geotechnical systems.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	**Physical Properties:** Overview of soil formation, Soil structure and clay mineralogy, Soil phase relationships, Index properties of granular and fine grained soils, Soil classification systems.	6	Characterisation of soil based on engineering properties
2	**Compaction**: General principles, Factors affecting compaction, Standard and modified Proctor tests, Effect of compaction on engineering properties, Field compaction.	5	Principles and methods of compaction of soil
3	**Permeability and Seepage:** Permeability of soils, Darcy's law, Equivalent permeability in stratified soils, In-situ and laboratory permeability test, Types of heads and seepage forces, Total and effective stress, Two-dimensional Laplace's equation, Flow nets, Uplift pressure, Exit gradient and piping, Filter criteria.	8	Evaluation of flow through soil medium
4	**Compressibility and Consolidation:** Components of total settlement, Compressibility of granular and fine grained soils, Terzaghi's 1-D consolidation theory, Consolidation test, Determination of preconsolidation stress, Overconsolidation ratio, Computation of settlement, Secondary consolidation.	8	Determination of consolidation characteristics of fine grained soil
5	**Shear Strength**: Mechanism of shear resistance, Mohr-Coulomb failure criterion, Measurement of shear strength: Direct shear test, Unconfined compression test, Vane shear test, Triaxial shear test (CD, CU, UU), Pore-pressure parameters, Stress path, Shear strength of clays and sands.	10	Evaluation of shear strength parameters of soil
6	**Stress Distribution**: Boussinesq's equation, Vertical stress due to line load, strip load, Uniformly loaded circular area, Westergaard's approach, Pressure bulb concept, Approximate methods..	4	Estimation of stress distribution

Text Books:

1. Holtz, R.D., Kovacs, W.D., Sheahan, T.C. (2013). An Introduction to Geotechnical Engineering, 2nd Edition, Pearson, India.
2. Ranjan, G. and Rao, A.S.R. (2016). Basic and Applied Soil Mechanics, 3rd Edition, New Age International Publishers, India.

Reference Books:

1. Murthy, V.N.S. (2006). Geotechnical Engineering, Marcel Dekker Inc, New York, USA.
2. Budhu, M. (2010). Soil Mechanics and Foundations, John Wiley & Sons.
3. Lambe, T.W. and Whitman, R.V. (1991). Soil Mechanics, John Wiley & Sons.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC 7	CEC209	Transportation Engineering	3	1	0	11

Course Objective

To provide basic knowledge in transportation so that students will be able to solve transportation related problems. The understanding of operation of different modes of transportation will enable the students to plan, design, operate and manage highways, railways and air transportation infrastructure in an efficient way.

Learning Outcomes

Upon successful completion of this course, students will:

- have basic understanding of factors influencing geometrical elements of different modes of transportation.
- be introduced to the concepts of design of various transportation infrastructure.
- know the application of scientific theories for maintenance of transportation infrastructure.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	**Highway Geometric Design:** Historical development of roads, Road development plans, Highway alignment surveys, Road patterns, Cross section elements, Sight distances, Horizontal and vertical alignment.	10	Understanding on various elements of Highway geometric design.
2	**Highway Materials and Pavement Design:** Desirable properties and quality control tests, Design factors for flexible and rigid pavements, Design of flexible and rigid pavement using relevant codes	8	Knowledge on characterization of highway materials and principles of pavement design using relevant codes
3	**Pavement Construction and Maintenance:** Construction of various layers of flexible pavement, Road construction equipment, joints in rigid pavements, Various types of failures, Evaluation and remedial Measures	4	Understanding on various road construction techniques and evaluation of road performance.
4	**Railway Engineering:** Components of Railway track, Stresses in Railway track, Railway alignment, concepts of cant excess and deficiency, safe permissible speed, transition curves, Widening of gauges and track clearances, Points and Crossings, Stations, Signaling	10	Basic understanding of railway components and railway geometric design principles.
5	**Airport Engineering**: Aircraft characteristics and their impact on planning of an airport, selection of site for an airport, airport obstruction, imaginary surfaces, runway orientation clam period and wind coverage, Runway and taxiway geometric designs, runway configuration.	7	Basic introduction to airport engineering and principles of airport planning and design.

Text Books:

1. Khanna, S. K., Justo, C. E. G. and Veeraragavan, A. (2017). *Highway engineering (*10th Edition), Nem Chand & Bros.
2. Chandra, S. and Agarwal, M.M. (2013). *Railway engineering*. Oxford University Press, Inc..
3. Khanna, S.K. Arora, M.G. and Jain, S.S. (1999). Airport Planning and Design, Nem Chand & Bros.

Reference books:

1. Thom, N. (2008). Principles of pavement engineering (p. 470). London: Thomas Telford.
2. Horonjeff, R., McKelvey, F. X., Sproule, W., and Young, S. (1962). *Planning and design of airports* (Vol. 4). New York: McGraw-Hill.
3. Chakroborty, P., and Das, A. (2017). *Principles of transportation engineering*. PHI Learning Pvt.Ltd
4. Huang, Y. H. (2004). *Pavement analysis and design*. Pearson Education.
5. Wright, P. H., & Paquette, R. J. (1987). Highway engineering.

Course Type	Course Code	Name of Course	L	T	P	Credit
DP 3	CEC 210	**Surveying Laboratory**	0	0	2	2

Course Objective

This course deals with basic and advanced surveying instruments, skills to use total Station for traversing an area, set out curves and to provide basic knowledge on GPS surveying and making map from field data.

Learning Outcomes

On successful completion of this course, student will be able to:

- Use and operate chain, tape, compass and theodolite in the field.
- Use total station in the field for various applications of civil engineering and setting out of curve.
- Understand the basic principles of GPS and map making.

Unit No.	Topics to be Covered	Laboratory	Learning Outcome
1	Measurement of distance and chaining across obstacles: chain and tape surveying	1	To know how to use chain and tape for horizontal measurement.
2	Measurement of bearings of sides of traverse using prismatic compass and computation of included angle.	1	To understand the use of compass for bearing measurement.
3	Measurement of horizontal angle with theodolite.	1	Understanding the concept of measurement of horizontal angle by theodolite.
4	Measurement of vertical angles and finding the height of an object using theodolite.	1	Understanding the concept of measurement of vertical angle by theodolite.
5	Traverse surveying using theodolite.	1	Understanding the concept of traverse of an area by theodolite.
6	Demonstration of various levelling instruments and differential/ fly levelling by Height of Instrument method.	1	To get knowledge on vertical measurement instruments and their methods.
7	Differential / fly levelling by Rise and Fall method.	1	Understand the concept of differential / fly levelling with advanced levelling instruments.
8	Demonstration of total station: Measurement of distance, angle between two stations.	1	Introduction to total station and working principle of total station for distance and angular measurement.
9	Traversing with total station.	1	Get practical knowledge on traversing with total station.
10	Setting out simple curve by Rankine's method using total station	1	To understand how to establish curves in the field.
11	Study of GPS and field data collection using GPS.	1	Knowledge on GPS and methods to collect GPS data in field.
12	Preparation of map using total station and GPS field survey data.	1	Knowledge on various open source software for plotting maps using GPS field data.
13	Evaluation	1	Evaluating the understanding of the course by the students.

Text Books / References:

1. Manual for Surveying Laboratory.

Course Type	Course Code	Name of Course	L	T	P	Credit
DP 4	CEC211	**Transportation Engineering Laboratory**	0	0	0	2

Course Objective
● To provide exposure to the students for various tests for characterization of materials used in road construction.
Learning Outcomes
● Students will get hands on experience on various tests pertaining to pavement material characterization and pavement performance evaluation.

Unit No.	Topics to be Covered	Laboratory	Learning Outcome
1	**Experiment-1:**Determination of crushing value and aggregate impact value aggregate **Experiment-2:** Determination of abrasion value of aggregate by Los Angele's abrasion test and determination of specific gravity test **Experiment-3:** Determination of Flakiness index, Elongation index and Angularity number of aggregates	3	Understating on various tests for characterization of aggregate for road construction.
2	**Experiment-4:** Determination of penetration value of bitumen **Experiment-5:** Determination of ductility of bitumen **Experiment-6:** Determination of softening point and flash and fire point of bitumen of bitumen **Experiment-7:** Determination of viscosity of bitumen and specific gravity of bitumen	4	Understating on various tests for characterization of bitumen for road construction.
3	**Experiment-8:** Determination of optimum binder content of bitumen mix by Marshall Stability Method **Experiment-9:** Determination of bitumen content of bitumen mix	3	Understating on various tests for evaluation of properties of prepared bitumen mix.
4	**Experiment-10**Performance evaluation of pavement	2	Understanding on the tests carried out for performance evaluation of constructed pavement

Text Books:

1. Relevant Indian and International Standard codes of practices.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC 8	CEC301	**Structural Analysis-II**	3	0	0	9

Course Objective
Advanced analysis of indeterminate structures will be focused in this course. Further, exposure to software will also be emphasized.
Learning Outcomes
After studying this course, students should be able to: • Have exposure towards analysis of indeterminate structures. • Carry out Sway analysis of frames - important for design of multi-storey building. • Software based analysis of structures

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	**Introduction to ILD:** Use of influence line diagrams, application to determinate structures	**3**	Understanding effect of moving load and procedure to plot ILD
2	**Application of ILD in indeterminate structures**: Influence lines for statically indeterminate structures, Muller-Breslau principle with application to determinate and redundant structures, Qualitative ILD for continuous beams and frames.	**6**	Structural behavior under rolling loads by qualitative ILD, ILD of indeterminate beams/bridge-girders loaded with concentrated and uniformly distributed loads
3	**Slope-deflection method:** Basic principles, slope deflection method for beams and frame with/without sway.	**7**	Development of stiffness factors, advantages and use of displacement based slope-deflection method of analysis in continuous beams and plane frames
4	**Moment distribution method**: Basic principles, Moment distribution method for beams and frame with/without sway, use of symmetry and anti-symmetry.	**8**	Idea of distribution factors, carry over moment and use of symmetry/anti-symmetry for analysis of continuous beams and plane frames
5	**Direct stiffness method:** Basic principles, application to planar structures - trusses, beams and frames, Analysis for temperature stress, lack of fit and settlement of supports.	**9**	Developing element stiffness matrix, local and global co-ordinate system, assembly, boundary conditions and solution procedure.
6	**Software application:**, Introduction to software and its applications to 2D trusses and frames.	**6**	Use of worksheet and elementary programming for application of structural analysis methods, introduction to commercial software

Recommended Text Books:

1. Wang, C. K., “Indeterminate Structural Analysis”, Tata McGraw Hill Publishing.
2. Kinney, J.S., “Indeterminate Structural Analysis”,Oxford IBH Publishing Company.

Recommended References:

1. Ghali, A. and Neville, A. M., “Structural Analysis (Unified Classical and Matrix Approach)”, 5th Edition, Chapman and Hall, Ltd.
2. Weaver, W., and Gere, J.M., “Matrix Framed Structures”, CBS Publishers, Delhi
3. Hibbeller, R. C., “Structural Analysis”, 6th Edition, Pearson Education

Course Type	Course Code	Name of Course	L	T	P	Credit
DC 9	CEC302	Foundation Engineering	3	0	0	9

Course Objective

To develop an understanding of concepts regarding the stability and settlement analysis of Geotechnical problems.

Learning Outcomes

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

- Apply the principles of mechanics for the analysis of Geotechnical problems.
- Determine the stability of slopes and retaining structures.
- Analyze and design the shallow and deep foundations.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	**Stability of slopes:** Stability analysis of infinite slopes, Stability analysis of finite slopes, Swedish circle method, Friction circle method, Bishop's method, Taylor's stability number and use of charts, stability analysis of earth dam slopes for different conditions.	9	Analytical methods of slope stability analysis.
2	**Earth pressures:** Earth pressure theories of lateral earth pressure, Active and passive earth pressures in cohesion less and cohesive soils, Rankine's and Coulomb's earth pressure theories Types of retaining structures, Stability considerations of gravity and cantilever retaining walls.	8	Study and evaluation of lateral earth pressure in soil. Stability analysis of rigid retaining structures.
3	**Bearing Capacity:** Terzaghi's bearing capacity theory, computation of bearing capacity in soils, Bearing capacity of Square, Rectangular, Circular and Continuous footings, Meyerhof's theory, Skempton's method, Effect of ground water table on bearing capacity.	6	Determination of bearing capacity of soil.
4	**Foundations:** Types of foundations, Depth of foundation, Design of shallow foundations from laboratory and field test data, Settlement analysis of footings	6	Geotechnical design and settlement evaluation of shallow foundations.
5	**Pile Foundation:** Classification of piles, Load carrying capacity of piles, Types and methods of construction, estimation of pile capacity from static and dynamic formulae, Group action of piles, capacity and settlement of group of piles, Pile load tests. Negative skin friction.	10	Introduction to pile and its capacity determination.

Text Books:

1. Das, B.M. (2011). Principle of Foundation Engineering, 7th Edition, Cengage Learning, USA.
2. Ranjan, G. and Rao, A.S.R. (2016). Basic and Applied Soil Mechanics, 3rd Edition, New Age International Publishers, India.

Reference Books:

3. Murthy, V.N.S. (2006). Geotechnical Engineering, Marcel Dekker Inc, New York, USA.
4. Budhu, M. (2010). Soil Mechanics and Foundations, John Wiley & Sons.
5. Arora, K.R. (2012). Soil Mechanics and Foundation Engineering, 6th Edition, Standard Publishers Distributors, India.

Course Type	Course Code	Name of the course	L	T	P	Credit
DP 5	CEC303	**Structural Engineering Laboratory**	0	0	2	2

Course Objective
Experimental evaluation of properties and behaviour of steel and concrete subjected to simple loading
Learning Outcomes
After studying this course, students should be able to: ● To understand the buckling behaviour of column ● Determination elastic properties of given models ● Evaluation of mix proportions for given strength of concrete ● To know different NDT tests on concrete

Unit No.	Topics to be Covered	Laboratory	Learning Outcome
1	**Experiment-1** Influence of boundary conditions on the buckling of columns.	**1**	To understand the buckling behaviour of column
2	**Experiment-2** Influence of eccentricity and lateral loading on the buckling of columns.	**1**	To understand the buckling behaviour of eccentric column
3	**Experiment-3** Determination of flexural rigidity of beam under lateral loading	**1**	Determination elastic properties of given steel beam models
4	**Experiment-4** Verification of Betti's law	**1**	Determination elastic properties of given steel beam models
5	**Experiment-5** Torsion Test: Circular section	**1**	Determination elastic properties of cylindrical rod.
6	**Experiment-6** Concrete Mix Design by IS Code, Casting of Test Samples and Workability Tests	**1**	Evaluation of mix proportions for given strength of concrete
7	**Experiment-7** Design, Casting and Testing of Under-Reinforced Concrete Beam	**1**	Understand the behavior of under reinforced beam its moment of resistance.
8	**Experiment-8** Design, Casting and Testing of Over-Reinforced Concrete Beam	**1**	Understand the behavior of over reinforced beam its moment of resistance.
9	**Experiment-9** Compressive, Split-tensile and Flexural Strength of testing samples	**1**	Determination of properties of hardened concrete.
10	**Experiment-10** Test for Determination of Static Modulus of Elasticity of Concrete	**1**	Determination of elastic properties of hardened concrete.
11	**Experiment-11** Non-Destructive Test of Concrete – Rebound Hammer and UPV	**1**	To know different NDT tests on concrete
12	**Revision and Evaluation**	**2**	

Text Books:

1. Relevant Indian and International Standard codes of practices.

Course Type	Course Code	Name of Course	L	T	P	Credit
DP 6	CEC304	Geotechnical Engineering Laboratory	0	0	2	2

Course Objective
To conduct the various testing on soils and evaluate their engineering characteristics by laboratory procedures.
Learning Outcomes
Upon successful completion of this laboratory, students will: ● Be able to perform the various laboratory experiments on soils ● Able to compute and analyze the results of the respective laboratory tests

Unit No.	Topics to be Covered	Laboratory	Learning Outcome
1	**Experiment 1** Atterberg limits of soil: Liquid limit, Plastic limit, and Shrinkage limit Free swell index of soil	1	Determine the Atterberg limits of clayey soil
2	**Experiment 2** Field unit weight (field density): Core cutter, and Sand replacement method	1	Able to find the insitu density of soil strata
3	**Experiment 3** Compaction of soil: Standard/Modified proctor test	1	Study the dry density and moisture content relationship
4	**Experiment 4** Laboratory permeability of soil: Falling head, and Constant head method	1	Determine the permeability of given soil sample
5	**Experiment 5** Consolidation characteristics of soil: Consolidation/Oedometer test	1	Evaluate various consolidation parameters
6	**Experiment 6** Shear Strength of soil: Vane shear and Direct shear test	1	Evaluate the strength parameters of soil
7	**Experiment 7** Shear Strength of soil: Unconfined Compression test	1	Evaluate the strength parameters of soil
8	**Experiment 8** Shear Strength of soil: Unconsolidated Undrained triaxial test	1	Evaluate the strength parameters of soil
9	**Experiment 9** California Bearing Ratio of soil: Soaked/Unsoaked CBR test	1	Evaluate the CBR value of subgrade for design of pavements
10	**Project, Revision and Evaluation**	4	Minor project

Text Books:

1. Respective Bureau of Indian Standard/ International Standard Codes of Practices.
2. Bowles, J.E. (2012). Engineering Properties of Soil and their Measurement, 4th Edition, McGraw Hill (India) Publishers.
3. Mandal, J.N. and Divshikar, D.G. (1994). Soil Testing in Civil Engineering, Oxford & IBH Publishing Company Pvt. Ltd., New Delhi, India.
4. Sivakugan, N., Arulrajah, A. and Bo, M.W. (2011). Laboratory Testing of Soils, Rocks and Aggregates, J.Ross Publishing.

Course Type	Course Code	Name of the course	L	T	P	Credit
DC 10	CEC305	**Design of Steel Structures**	3	0	0	9

Course Objective

The primary focus of this course is to understand the design philosophy of steel structures along with design methodology of different structural components based on Indian Standard.

Learning Outcomes

After studying this course, students should be able to:

- Understand the design philosophy of steel structures.
- Design different structural elements under various loading conditions based on Indian Standard.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	Types of structural steel, Loading as per IS: 875, load Combinations, Design Load, Wind Load, I.S. rolled sections, Design philosophy, elastic method, limit state design.	**5**	To get exposer to different types of structural steel along with the concept of different design philosophy and loading conditions.
2	Riveted, bolted and welded connections, failure of joints, efficiency of joints, design of bolted, welded joints for axial and shear force, HS Friction bolts.	**10**	Able to analyse and design of different types of connections
3	Steel members subject to axial tension, L.S. Design of tension members, Design rules, Design of compression members for axial force, effective lengths, Design rules, Built up columns, Design of lacing and batten plates, Column bases, slab base, gusseted base and grillage footings.	**14**	Concept to know the analyse and design of tension and compression members
4	Stability of flange and web, stability consideration, uniaxial loading, biaxial loading, Design of rolled steel sections, stiffeners, Simple Beam end connections, Beam-Column connections.	**6**	Concept to know the analyse and design of flexural members
5	Design of trusses and purlins.	**4**	Able to analyse and design of industrial truss structures

Recommended Text Books:

1. I. C. Syal and Satinder Singh, Limit State Design of Steel Structures, Standard Publishers Distributors.

Recommended References:

1. S. S. Bhavikatti, Design of Steel Structures, I.K. International Publishing House Pvt. Ltd.
2. S. K. Duggal, Design of Steel Structures, McGraw Hill.
3. N. Subramanian, Design of Steel Structures, Oxford University Press.

Course Type	Course Code	Name of Course	L	T	P	Credit
DC 11	CEC306	**Water Resources Engineering**	3	0	0	9

Course Objective
To familiarize the students with the basic concepts in hydrology, open channel hydraulics and irrigation engineering.
Learning Outcomes
Upon successful completion of this course, students will be able to: ● Understand the concepts involved in hydrology, open channel hydraulics. ● Perform design and analysis of hydrologic and hydraulic systems. ● Know the different types of irrigation systems in practice.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	**Hydrology** **Introduction:** World's water resources, basic concepts of hydrologic cycle and water budget. **Precipitation and Hydrologic Abstractions:** Measurement of precipitation, probable maximum precipitation (PMP), consistency of rainfall record, handling missing records, frequency analysis, Measurement and estimation of infiltration and Evapotranspiration. **Runoff, Hydrographs, Streamflow:** Runoff coefficients, mass curve, hydrograph analysis, base flow separation, Direct runoff hydrograph, S-curve hydrograph, Unit hydrograph, gauge-discharge relationship. **Subsurface hydrology:** Divisions of sub-surface water, Types of aquifers, Steady state flow in confined and unconfined aquifers, Darcy's law.	**17**	Understand the role of different components in the hydrologic cycle. Perform hydrograph analysis. Analyse simple sub-surface flow situations.
2	**Open Channel Flow** **Introduction:** Principles of open channel flows, Classification of open channel flow, Basic equations governing channel flows, Velocity and pressure distribution, Energy and momentum equations and coefficients. **Uniform and critical flow computations:** Energy depth relationships, Specific energy and force concepts, critical and normal depths, Chezy's and Manning's coefficients, Hydraulically efficient channel sections. **Non uniform flow:** Gradually and Rapidly varied flow, Hydraulic jump.	**17**	Understand the characteristics of flow .Analyse flow situations like critical, sub-critical and super-critical flow. Know the non-uniform flow concepts.
3	**Irrigation Engineering** **Water requirement of Crops:** Introduction to different types of irrigation, Crop period and Base period, Duty and Delta, Water holding capacity of soil, consumptive use of water, irrigation efficiencies. **Irrigation appurtenances:** Lined and unlined canals, gravity dams, head works and spillways.	**5**	Basic understanding of the water requirement of crops, methods of irrigation and irrigation appurtenances

Text Books:

1. Subramanya, K. (2017), 4th edition, Engineering Hydrology, Tata McGraw Hill, India
2. Subramanya, K. (2015), 4th edition, Flow in Open Channels, Tata McGraw Hill, India
3. Garg, SK. (2005), 19th edition, Irrigation Engineering and Hydraulic Structures, Khanna Publishers.

Reference Books:

1. D. R. Maidment, Ed., Handbook of Hydrology, McGraw-Hill, 1993
2. Chow, V.T., Maidment, D.R., Mays, L.W. (2010) Applied Hydrology, Tata McGrawHill Education Private Limited, India.

Course Type	Course Code	Name of the course	L	T	P	Credit
DP 7	CEC307	**Structural Detailing Laboratory**	0	0	2	2

Course Objective
To acquire exhaustive knowledge on design and detailing of various structural components of civil infrastructures.
Learning Outcomes
After studying this course, students should be able to: ● Understand the design and detailing of various members of concrete structures. ● Develop knowledge on design and detailing of connections and components of steel structures.

Unit No.	Topics to be Covered	Laboratory	Learning Outcome
1	**Sessional-1** Design and detailing of singly and doubly reinforced concrete beams.	**1**	Understand the detailing of reinforced concrete beams
2	**Sessional -2** Detailing of one way and two-way concrete slabs	**1**	Acquire knowledge on detailing of one-way and two-way slabs
3	**Sessional -3** Detailing of staircase	**1**	Familiar with detailing of staircase
4	**Sessional -4** Detailing of RC columns and footings	**1**	Comprehend the detailing of columns and footings
5	**Sessional -5** Detailing of retaining walls	**1**	Understand the detailing of retaining wall
6	**Sessional -6** Detailing of bolted and welded connections of steel structures	**1**	Knowledge on detailing of various connections of steel structures
7	**Sessional-7** Detailing of tension and compression members	**1**	Understand the detailing of tension and compression members
8	**Sessional -8** Detailing of laced and battened columns	**1**	Comprehend the detailing of steel columns with lacing and batten
9	**Sessional -9** Detailing of steel beams and beam-column connections	**1**	Knowledge on detailing of steel beams and beam-column connections
10	**Sessional -10** Detailing of column base and gusset base	**1**	Understand the detailing of column base and gusset base
11	**Sessional -11** Detailing of roof truss with purlins	**1**	Grasp the detailing of roof truss with purlins
12	**Revision and Evaluation**	**2**	

Text Books:

1. Relevant Indian and International Standard codes of practices.

Course Type	Course Code	Name of Course	L	T	P	Credit
DP 8	CEC308	**Water Resources Engineering Laboratory**	0	0	2	2

Course Objective
To familiarize with the various fundamental aspects of fluids, their behavior and the applications of fluid mechanics and machines as well as open channel flow.
Learning Outcomes
Upon successful completion of this course, students will: ● Understand the basic concepts of Fluid mechanics. ● Develop practical understanding of the basic theories in Fluid mechanics and Open Channel flow. ● Understand the working principle of hydraulic machines. ● To understand the concepts of hydrology.

Unit No.	Topics to be Covered	Laboratory	Learning Outcome
1	Verification of Bernoulli's theorem	1	Understanding the principle of conservation of energy
2	Determination of Coefficient of discharge of Venturimeter & Orifice meter	1	To know different methods to measure discharge through pipes
3	Determination of losses in pipe flow	1	Understanding the nature of pressure loss occurring through pipes for real fluids.
4	Determination of Coefficient of discharge for notches	2	Knowledge on various methods for flow measurement in open channels
5	Study of hydraulic jump in open channel flow	1	To understand the methods of energy dissipation used in hydraulic structures.
6	Performance studies on Turbines	2	To know the working principle and efficiency of turbines
7	Performance studies on Pumps	2	Understanding the working principle and efficiency of different type of pumps
8	Measurement of Infiltration by Infiltrometer and evaporation by Pan evaporimeter	1	To understand the process of infiltration and evaporation and their quantification
9	Determination of hydrograph after precipitation in Hydrology system equipment	1	To know the process and method of measuring runoff after precipitation by hydrograph.
10	Evaluation	1	Evaluating the understanding of student regarding the lab course.

Text Books / References:

1. Manual for Water Resources Engineering Laboratory

Course Type	Course Code	Name of Course	L	T	P	Credit
DE 1	CED401	Traffic Engineering and Management	3	0	0	9

Course Objective

The course encompasses principles of traffic engineering and introduces different management techniques to mitigate the traffic problems. The course introduces the student to concepts of characterizing traffic, application of various modeling approaches, and design of traffic facilities to control and manage traffic.

Learning Outcomes

Upon successful completion of this course, students will:

- understand of basic of traffic stream parameters.
- able to develop model for traffic flow.
- know theories and applications of traffic intersection control

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Traffic stream characteristics and measurement**: Road user characteristics, Fundamental parameters and relations of traffic flow, Traffic stream models, Moving observer method, Measurement at a point; Measurement over a short section, Measurement along a length of road, Automated traffic measurement, Traffic surveys.	11	To understand the fundamental parameters of traffic stream and various methods of measurement of these parameters.
2	**Microscopic traffic flow modelling:** Car-following models, Lane changing models, gap acceptance models; Vehicle arrival models.	5	Introduction to various microscopic and car following models of traffic flow.
3	**Uninterrupted flow and intersection control:** Capacity and Level of service LOS, Urban Street, Multilane highways, Freeway operations, Corridor analysis. Principles of traffic control, Traffic signs and road markings, Uncontrolled intersection, Channelization, Traffic rotary, Grade separated intersection.	10	To understand capacity and level of service concepts of various traffic facility and to know various control techniques.
4	**Traffic signal design:** Elements of traffic signal, Design principles of a traffic signal, Evaluation of a traffic signal, Capacity and LOS analysis of a signalized I/S: Coordinated traffic signal.	7	To know principles of traffic signal design and its coordination.
5	**Specialised traffic studies:** Parking Studies, Accident Studies: Congestion studies, Toll operation, Pedestrian studies.	5	To understand principles of various specialized traffic studies.

Text Books:

1. Roess, RP., McShane, WR. and Prassas, ES. (1998), Traffic Engineering, Prentice Hall.
2. Papacostas, C. S. (1987), Fundamentals of Transportation Engineering, Prentice Hall.
3. Kadiyali, LR (1987), Traffic Engineering and Transportation Planning, Khanna.
4. Khanna, S. K. and Justo, C. E. G. (1991), Highway Engineering, Nemchand.

Reference books

1. May, A. D. (1990), Fundamentals of Traffic Flow, Prentice Hall.
2. Highway Capacity Manual (2000), Transportation Research Board, USA.
3. Pingnataro, G. J. (1970), Principles of Traffic Engineering, Mc Graw - Hill.

Course Type	Course Code	Name of the course	L	T	P	Credit
DE 2	CED402	**Advanced Design of Structures**	3	0	0	9

Course Objective

Advanced analysis and design of various concrete and steel structures including flat slab, ribbed slab, deep beam, gantry girder and industrial truss will be focussed in this course. Further, serviceability criteria and vibration control will also be emphasized.

Learning Outcomes

After studying this course, students should be able to:

- Have exposure towards inelastic design of beams and slabs.
- To design of the structures like compression member under biaxial bending, deep beam, flat slab, industrial truss etc.
- Estimate the serviceability requirement and have idea for vibration control.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	Introduction: Recapitulate the basics of RCC design, Plastic hinge and plastic rotation for RC element under bending, Redistribution of moments and moment rotation characteristics of RC member, Design of Compression members under Biaxial Bending, Design of Slender Columns.	[**12L**]	Understand basics of plastic analysis. Exposure for moment redistribution. To know the design of compression members subjected to biaxial bending. Further, to learn the design of slender columns.
2	Limit state of Serviceability: Limit state of Serviceability: Deflection, crack width estimation and vibration control for RC beam and slab.	[**10L**]	Exposure towards in-depth knowledge about limit state of serviceability (deflection and crack width).
3	Design of slab and Yield Line Analysis: Design of Flat slabs and Ribbed slabs. Yield line analysis and design of square and circular slabs for different support conditions by virtual work and equilibrium methods.	[**5L**]	To know the analysis and design of slabs using yield line theory. To learn the technique for design of flat slabs.
4	Design of Deep Beams: Design and detailing of simply supported and continuous RC deep beams.	[**6L**]	Exposure towards design and detailing of deep beam.
5	Gantry girder and Industrial Truss: Design of plate girder and gantry girder, Design of industrial truss.	[**6L**]	To learn the design of gantry girder and industrial truss.

Recommended Text Books:

1. Pillai, S. U. and Menon, D. (2014). Reinforced Concrete Design, Third Edition, Mc Graw Hill.
2. Subramanian, N. (2016). Design of Steel Structures-Limit States Method, Oxford University Press.
3. Varghese, P. C. (2005). Advanced Reinforced Concrete Design. PHI.

Recommended References:

1. Park, R., Paulay, T. Reinforced concrete structures, John Wiley & Sons.
2. Subramanian, N. (2014). Design of Reinforced Concrete Structures, Oxford University Press.

Course Type	Course Code	Name of Course	L	T	P	Credit
DE 3	**CED403**	**Advanced Hydrology**	3	0	0	9

Course Objective
The course will familiarize the students with the advanced concepts in hydrology.
Learning Outcomes
After studying this course, the students should be able to: • perform analysis of hydrologic systems using the knowledge of hydrologic processes, their relationship with climate and hydrologic statistics

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	**Hydrologic cycle:** Hydrologic cycle and its components, Watershed, Regional Water Balance, Storage effects, Residence time, Hydrologic Modeling, Types of Models	**11**	Knowledge of the distribution of water in terrestrial, oceanic and atmospheric components of the global water system Understanding the basics of hydrologic modeling
2	**Hydrology and Climate:** Energy Budget of the Earth, Latitudinal energy transfer, General circulation and distribution of Pressure and Temperature, Teleconnections, Fluxes in the Global cycle, Distribution of Precipitation, Evaporation and Runoff, Climate change and the hydrologic cycle	**10**	Understanding of the interrelationship of hydrology and climate
3	**Hydrologic Statistics:** Hydrologic data analysis, Estimating parameters of probability distributions, Persistence and auto-correlation, Effects of persistence on uncertainty of time series statistics and correlation estimates, Statistical criteria for model calibration and validation.	**10**	Knowledge of the standard statistical techniques applicable for analyzing hydrologic quantities
4	**Hydrologic Analysis:** Floods, Framework for Floodplain Management, Low-flow frequency analysis, Drought analysis	**8**	Understanding of hydrological extremes, ie., floods and droughts

Text Books:

1. Dingman L. S. (2002), “Physical Hydrology”, 2nd Ed. Waveland Press, Inc., USA

Reference Books:

4. Chow, V T., D. R. Maidment and L. W. Mays (1988), “Applied Hydrology”, McGraw-Hill, Inc., New York.
5. Maity R. (2018), “Statistical methods in Hydrology and Hydroclimatology”, 1st Edition, Springer, Singapore.
6. Hann C.T. (1995), "Statistical Methods in Hydrology", First East-West Press Edition, New Delhi.
7. Box, G. E. P., G. M. Jenkins, and G. C. Reinsel (2003), “Time Series Analysis, Forecasting and Control”, Pearson Education, Singapore.

Course Type	Course Code	Name of the course	L	T	P	Credit
DE 4	CED404	Environmental Engineering II	3	0	0	9

Course Objective

This course is to provide an understanding the functioning and design of various water and waste water treatment methodologies.

Learning Outcomes

After studying this course, students should be able to:

- Understand the role of each unit process within typical treatment process trains, their interaction and the context of when they are applied.
- Appreciate the advantages, disadvantages and limitations of the technologies adopted for waste water treatment

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	Design of water treatment units, Design and operation of Plain Sedimentation (type-1 settling) and Sedimentation aided coagulation (type-2 settling), Design of filtration systems – slow sand and rapid sand filter, Design of disinfection – Chlorination and other means of disinfection, , water softening - lime soda process, single stage and two stage, re-carbonation, ion exchange	**[12L]**	Understand the operation and design of treatment units of water treatment plants.
2	Industrial Wastewater and Sewage characteristics, Environmental Standard for domestic and industrial wastewater disposal, Quantity & Quality, flow rate, treatment flow -sheets. Design of Sewerage: Types & Design of sewerage, Hydraulic Design of Sewer: construction laying and testing of sewer lines, Design of Sewage Pumping Station, Maintenance of sewerage system.	**[10L]**	Understand the fundamentals of sewerage design.
3	Sewage treatment process, reactor type, Preliminary treatment-design and operation of screening and grit chamber. Sedimentation, design and operation PST, Sewage disposal in isolated unsewered areas: septic tank, cesspools and their effluent disposal methods.	**[7L]**	An understanding of the operation and design of primary treatment units of wastewater treatment systems.
4	Principle of biological treatment-derivation of bacterial growth kinetics used in designing of wastewater treatment plant. Process design and operation of Activated sludge process and its modification. Design of secondary settling tank. Design and operation of nutrient removal system, Process design and operation of trickling filter, RBC, Biofilter. Anaerobic treatment: Design and operation of UASB process. Sludge characteristics and disposal methods: design and operation of sludge drying bed. Concept of common effluent treatment plant (CETP). Wastewater treatment for small communities: Oxidation ditch, SBR and lagoon etc.	**[10L]**	An in-depth-knowledge of the secondary (biological) treatment of wastewater.

Recommended Text Books:

1. Wastewater Treatment Plants: Planning, Design and Operation Holt - SR Qasim, Rinehart & Winston, NY, 1985.
2. Water and wastewater technology (7th ed.)- Hammer and Hammer, PHI, Delhi.

Recommended References:

1. Wastewater Engineering: Treatment and Reuse (4th ed.)-Metcalf and Eddy
2. Wastewater Treatment for Pollution Control (3rd ed.) - SJ Arceivala, Tata McGraw Hill,1998.

Course Type	Course Code	Name of Course	L	T	P	Credit
OE 1	CEO401	Flow and Transport through Porous Media	3	0	0	9

Course Objective

This course is designed to provide students a fundamental understanding of flow and transport processes occurring within the porous systems.

LearningOutcomes

Upon successful completion of this course, students will:

- Understand theoretical principles for characterizing and predicting single phase flow processes in porous systems.
- Have an in-depth knowledge of multiphase flow processes in porous systems.
- Have a basic understanding on flow and transport processes in fractured rock systems.
- Understand various transport mechanisms influencing the fate and transport of solutes in porous systems.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	**Introduction to Flow through Porous Media:** Types of Porous Media. Application of study- Groundwater engineering, Oil Exploration, Mining, Waste Disposal, Geothermal Energy Extraction **Single Phase Fluid Flow:** Introduction to single phase and multiphase fluid systems. Concept of Porosity, Permeability, Factors affecting Porosity and Permeability, Correlations between porosity and permeability, Fluid movement below and above the water table, Reynolds number in Porous Media Flow, Darcy's Law and range of validity, Experimental determination of permeablity- Constant and variable head Permeameters, Mass, Momentum and Energy Conservation Equations for Fluid movement in Porous media, Steady state flow concepts- Laminar and Turbulent flow, Derivation of Diffusivity Equation for Single phase fluid flow.	[**16L**]	Understand theoretical principles for characterizing and predicting single phase flow processes in porous systems.
2	**Multiphase fluid flow:** Multiphase flow through porous systems, Concept of Relative Permeability, Saturation, Wettability and Capillary Pressure, Capillary pressure-Saturation relationship, Darcy's Law for Multiphase flow, Immiscible displacement, Buckley-Leverett theory, Multiphase mass continuity equation. **Fractured rock-system:** Flow and Transport mechanism through fractured rock systems, Comparison between flow and transport processes through classical porous media and fractured rock systems.	[**14L**]	Have an in-depth knowledge of multiphase flow processes in porous systems. Have a basic understanding on flow and transport processes in fractured rock systems.
3	**Transport Mechanisms:** Advection, Diffusion, Fick's Law, Hydro-dynamic Dispersion, Concept of Tortuosity, Advection-Dispersion Equation, Sorption- Physisorption and Chemisorption, Equilibrium and Kinetic Sorption, Dissolution, Biodegradation, Radio-active decay, Concept of Single-component and Multi-component solute transport.	[**9L**]	Understand various transport mechanisms influencing the fate and transport of solutes in porous systems.

Text Books:

1. Amit, P. (2014), Introduction to Fluid Flow through Porous Media, Lambert Academic Publishing.
2. Civan, F.(2011), Porous media transport phenomena, John Wiley & Sons, Inc.

Reference Books:

1. Sahimi, M. (2011),Flow and Transport in Porous Media and Fractured Rock: From Classical Methods to Modern Approaches, 2nd Edition, Wiley-VCH Verlag GmbH & Co. KGaA.
2. Bear, J.(1972),Dynamics of fluids in porous media,Environmental science series, New York.
3. Rastogi, A.K. (2007), Numerical Groundwater Hydrology, 1st Edition, Penram International Publishing.

Course Type	Course Code	Name of Course	L	T	P	Credit
OE 2	CEO301	Reliability and Risk Assessment	3	0	0	9

Course Objective

To provide the students a thorough understanding of the key concepts behind reliability and risk analyses of engineering structures.

Learning Outcomes

Knowledge of risk assessment methods for decision making under uncertain conditions.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Uncertainty and Reliability:** Sources of uncertainty in Geotechnical design parameters, In-situ soil characterization, Sensitivity analysis, Modelling of uncertainty	4	Concepts of uncertainty and reliability in Geotechnical Engineering
2	**Methods of reliability analysis:** Fragility curves, Probability of failure, FORM, Monte Carlo Simulation Techniques, Response Surface Method, Parallel and series systems. Explicit and implicit functions, Target reliability index, LRFD approach	12	Methods of reliability analysis.
3	**Application of reliability analysis:** Applications to shallow and deep foundations, landslides and embankments, liquefaction behavior of soils.	8	Application of reliability analysis to field problems.
4	**Risk Assessment and analysis**: Concept of risk, objective and scope of risk assessment, Probabilistic risk, Risk perception and acceptability, Quantitative aspects of risk. Three levels of risk quantification, PRA management, Preliminary hazard analysis.	15	Concepts of risk assessment and analysis

Text Books:

1. Baechaer, G. and Christian, J. (2005). Reliability and Statistics in Geotechnical Engineering, Wiley Publications.
2. Griffiths, D.V. and Fenton, G.A. (2007). Probabilistic Methods in Geotechnical Engineering, Springer.

Reference Books:

3. Haldar, A. and Mahadevan, S. (2000). Probability, Reliability and Statistical Methods in Engineering Design,Wiley.
4. Phoon, K.K. (2008). Reliability based Design in Geotechnical Engineering: Computations and Applications, Taylor and Francis.

Course Type	Course Code	Name of Course	L	T	P	Credit
OE 3	CEO302	Optimization Methods	3	0	0	9

Course Objective
To make students acquainted with basics of linear and non-linear optimization methods.
Learning Outcomes
The students will have ability to apply the optimization methods for the solution of engineering problems

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Introduction to Optimization Problems:** Basics of engineering analysis and design, Need for optimal design, formulation of optimal design problems, basic difficulties associated with solution of optimal problems.	4	Understanding and formulation of optimization problems in engineering
2	**Analytical Methods of Nonlinear Optimization Problems**: Classical optimization methods, Necessary and sufficient optimality criteria for unconstrained and constrained problems, Kuhn-Tucker conditions, Global optimality and convex analysis.	12	Solution of non-linear optimization problems using analytical methods
3	**Formulation and Solution of Linear Optimization Problems:** Linear optimal problems, Simplex method, Introduction to Karmarkar's algorithm.	7	Solution of linear optimization problems using different methods
4	**Numerical Methods of Nonlinear Optimization Problems:** Numerical methods for nonlinear unconstrained and constrained problems, sensitivity analysis	12	Solution of non-linear optimization problems using numerical techniques.
5	**Introduction to Evolutionary Methods of Optimization:** Introduction to evolutionary methods: Genetic algorithm and simulated annealing.	4	Introduction to alternative methods of optimization.

Text Books:

1. Deb, K. (1998). Optimization for engineering design: Algorithms and examples, PHI Pvt Ltd.
2. Arora, J.S. (1989). Introduction to optimum design, McGraw Hill International editions.

Reference Books:

3. Hafta, R.T. and Gurdal, Z. (1996) Elements of structural optimization, third revised and expanded edition. Kluwer academic publishers.
4. Rao, S.S. (1996). Engineering optimization theory and practice.

Course Type	Course Code	Name of Course	L	T	P	Credit
OE 4	CEO402	Ground Improvement and Geosynthetics	3	0	0	9

Course Objective

To understand various ground improvement techniques along with principles, design and construction procedures for the construction sites which are not suitable for supporting any physical infrastructure.

Learning Outcomes

Student will learn about various ground improvement techniques, their design and field implementation along with various case studies where ground failures were resolved using ground improvement techniques and the application of geosynthetics for ground improvement and containment purpose

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Introduction:** Need for ground improvement, Different types of problematic soils, Classification of ground improvement techniques, Emerging trends in ground improvement.	2	Introduction to Engineering Ground Modification.
2	**Mechanical Stabilization**: Shallow and Deep Compaction: Conventional and Intelligent compaction, Deep dynamic and Rapid impact compaction, Vibro compaction, Blasting densification. Deep Replacement: Stone Columns, Vibro concrete columns. Design and Construction Methods.	5	Shallow and Deep Ground Improvement by Mechanical Stabilization methods
3	**Hydraulic Modification:** Drainage and Dewatering System: Dewatering methods, Design of dewatering systems, Prefabricated vertical drains, Vacuum consolidation, Electro-kinetic dewatering, Design and construction methods.	5	Ground Improvement by Hydraulic modification methods
4	**Chemical and Thermal Modification:** Modification by Admixtures: Lime and Cement columns, Admixtures in Pavement design, Stabilization of Industrial Waste. Modification by Grouting: Different Types of grouting, Grouting techniques and control. Thermal Modification: Heat Treatment of Soils, Ground Freezing, Design and construction methods	5	Ground Improvement by Physical and Chemical Modification methods
5	**Modification by Inclusions and Confinement:** Soil nailing: Stabilization using soil nailing, Types, design and construction methods. Anchors: Design and construction methods, Soil Confinement by form work.	6	Ground Improvement by inclusions and confinement Techniques
6	**Geosynthetics:** Overview of geosynthetics: Major application areas, Manufacturing and testing, Properties: Physical, Mechanical, Endurance and Degradation properties. Geosynthetics Types: Geotextile, Geogrid, Geonet, Geomembranes, Geocell and GCL etc. Designing for Functions: Reinforcement, Separation, Filtration and Drainage etc. Designing of Geosynthetics in Transportation Infrastructure and Reinforced Soil Structures: Overburden Mine Slopes reinforced with Geosynthetics, Pavements, Embankments etc. Geosynthetics Reinforcement in waste containment Applications: Liquid contaminant Liners (Design with Geomembranes), Solid Containment (Landfill Covers and Liner system), Design with Geocomposites.	14	Geosynthetics application in various reinforced soil structures.
7	**Emerging and Innovative Topics**: Microbial and Nano-Technology in site remediation, Energy Geotechnology, Recent developments and Case studies of ground improvement projects.	2	Exposure to recent development in Ground Improvement Techniques

Text Books:

1. Korth, Slberchatz,Sudarshan, :"Database SystemConcepts", 6th Edition, McGraw –Hill Hausmann, M.R. (1990). Engineering principles of ground modification, McGraw Hill.
2. Koerner, R.M. (2012). Designing with geosynthetics: Vol. 1 & 2, 6thEdition, Xlibris.
3. Babu, G.L.S. (2005). An introduction to soil reinforcement and geosynthetics, 1st Edition, Universities Press, India.

Reference Books:

4. Han, J. (2015). Principles and practice of ground improvement, 1stEdition, Wiley.
5. Van Impe W.F., Soil improvement techniques and their evolution, Balkema, 1989.
6. Moseley, M.P. and Kirsch K. (1993). Ground improvement, Taylor and Francis.
7. Shukla, S.K. and Yin, J.H. (2006). Fundamentals of geosynthetic engineering, Taylor and Francis, UK.

Course Type	Course Code	Name of the course	L	T	P	Credit
OE 5	CEO403	**Mechanics of Composite Materials**	3	0	0	9

Course Objective

To analysis the laminated composite plates and its behaviour

Learning Outcomes

After studying this course, students should be able to:

- To know the manufacturing process and homogenisation technique
- Concept to know the constitutive relation of laminated composite
- Concept to know the analysis of laminated composite plates
- Understand the failure theories of laminated composite plate

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	Composite Fundamentals, Classification and characteristics of composite materials, Constituent Materials for Composites, Manufacturing Processes. Micromechanical analysis of composite strength and stiffness.	[**6L**]	To know the manufacturing process and homogenisation technique
2	Elastic properties of unidirectional lamina, stress strain relationship, transformation of stress and strain, derivation of reduced stiffness matrix. Analysis of laminated composite, determination of lamina stresses and strains, coupling effects, All type of laminate configurations and its analysis. Computer program for finding stiffness matrix of multi layered laminate.	[**10L**]	Concept to know the constitutive relation of laminated composite
3	Analysis of laminated plates: Classical laminate plate theory for bending of composite plate. Navier's method of solution for analysing composite plates. Shear deformation theory for laminated plate: First order, higher order theory. Free vibration and stability analysis of laminated plates. Development of matlab programme for analyzing laminated plates.	[**14L**]	Concept to know the analysis of laminated composite plates
4	Failure theories and strength of a unidirectional lamina, Micromechanics of failure of unidirectional lamina. Anisotropic strength and failure theories: maximum stress theory, strain theory, Tsai-Hill criteria, Tsai-Wu criteria, Analysis of laminate strength.	[**8L**]	Understand the failure theories of laminated composite plate

Recommended Text Books:

1. Jones, R. M. (2014). *Mechanics of composite materials*. CRC press.

Recommended References:

1. Mukhopadhyay, M. (2005). *Mechanics of composite materials and structures*. Universities press

Course Type	Course Code	Name of the course	L	T	P	Credit
OE 6	CEO404	**Structural Dynamics**	3	0	0	9

Course Objective

The design of civil engineering structures has come to almost saturated stage under dead load and live load. Well lead design guidelines are existing. However, the issue becomes far more complicated while coming to dynamic loading like earthquake, wind, blast etc. This course may aim to address the basics for dealing with such loads.

Learning Outcomes

Students get aware of Dynamic of a system and building up basic for Earthquake resistant design philosophy.

Unit No.	Topics to be Covered	Lectures	Learning Outcome
1	Vibrations and the nature of time dependent phenomena, inertia, dynamic equilibrium and mathematical models of physical systems; Energy storing and dissipation mechanisms.	[**4L**]	Basics of vibration problem in generalised form
2	Dynamics of Single Degree of Freedom Systems, undamped and damped, free and forced vibrations; Steady-state and transient response, impulse response. Harmonic response and applications to vibration isolation.	[**14L**]	Solution of typical types of vibration problem in engineering
3	Concept of Response spectrum, Tripartite Spectrum for analysis due to generalized support motion.	[**6L**]	Application of concepts of dynamics for earthquake induced vibration
4	Modal Analysis; Eigen value problem; Mode Shape; Orthogonality of mode shape. Shear Building model.	[**8L**]	Modelling and solution of actual problems involving multi-degree of freedom
5	Approximate Methods for Vibration Analysis, Rayleigh quotient, Rayleigh Ritz method. Introduction to Random Vibration.	[**8L**]	Numerical aspect of vibration problem and introduction to relevant statistical concept

Recommended Text Books:

1. Chopra, A. K. “Dynamics of Structures”, PHI Learning.

Recommended References:

1. Clough, R. W. and Penzien., J., “Dynamics of Structures”, 2nd edition, Mc-Graw Hill Book Company.
2. Dutta, S. C. ,and Mukhopadhya, P.(2012).Improving earthquake and cyclone resistance of structures: Guidelines for the Indian subcontinent.
3. Paz, M. “Structural Dynamics Theory and Computation”
4. Craig, R. R., Jr. and Kurdila, A., “Fundamentals of Structural Dynamics”, 2nd edition, John Wiley & Sons.