Scheme of Instruction, Evaluation

and

Syllabi of

With effect from Academic Year 2024-2025

B.E. Civil Engineering

DEPARTMENT OF CIVIL ENGINEERING

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

OSMANIA UNIVERSITY

Hyderabad – 500 007, TG, INDIA

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SCHEME OF INSTRUCTION AND EVALUATION
B.E. (CIVIL ENGINEERING) w.e.f. 2024-25

BE V Semester

S.No	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	PC 501 CE	Soil Mechanics	3	-	-	3	3	40	60	3
2	PC 502 CE	Water Resource Engineering -I	3	-	-	3	3	40	60	3
3	PC 503 CE	Theory of Structures-I	3	-	-	3	3	40	60	3
4	PC 504 CE	Design of Steel Structures	3	-	-	3	3	40	60	3
5	PC 505 CE	Transportation Engineering	3	-	-	3	3	40	60	3
6		Professional Elective-II	3	-	-	3	3	40	60	3
Practicals										
7	PC 551 CE	Soil Mechanics Lab	-	-	2	2	3	25	50	1
8	PC 552 CE	Transportation Engg. Lab	-	-	2	2	3	25	50	1
		Total	**18**	**-**	**4**	**22**	**24**	**290**	**460**	**20**

Professional Elective-II

S.No	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
6.1	PE 501 CE	Retrofitting and Rehabilitation of structures	3		-	3	3	40	60	3
6.2	PE 502 CE	Applied Hydrology	3		-	3	3	40	60	3
6.3	PE 503 CE	Advanced Design of Concrete Structures	3		-	3	3	40	60	3
6.4	PE 504 CE	Airport Engineering	3		-	3	3	40	60	3

SCHEME OF INSTRUCTION AND EVALUATION
B.E. (CIVIL ENGINEERING) w.e.f. 2024-25

BE VI SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction			Contact hr/week	Scheme of Evaluation		Credits
			L	T	P		CIE	SEE	
1	PC 601 CE	Environmental Engineering	3		0	3	40	60	3
2	PC 602 CE	Theory of Structures-II	3		0	3	40	60	3
3	PC 603 CE	Structural Engg Design and Drg-I (Concrete)	3		0	3	40	60	3
4	PC 604 CE	Foundation Engineering	3		0	3	40	60	3
5	PC 605 CE	Water Resource Engineering -II	3		-	3	40	60	3
6	**Professional Elective – III**		3		-	3	40	60	3
7	**Open Elective – I**		3		0	3	40	60	3
Practical									
8	PC 651 CE	Environmental Engg. lab	0		2	2	25	50	1
9	PW 651 CE	Mini Project	-	-	6	6	50	-	3
10	PW 661 CE	Summer Internship			6				2
			21	**-**	**14**	**29**	355	470	**27**

Professional Elective – III

S.No	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
6.1	PE 601 CE	Pavement Construction & Management	3		-	3	3	40	60	3
6.2	PE 602 CE	Pre-stressed Concrete	3		-	3	3	40	60	3
6.3	PE 603 CE	Ground Improvement Techniques	3		-	3	3	40	60	3
6.4	PE 604 CE	Principles of Climate Change	3		-	3	3	40	60	3
6.5	PE 605 CE	Railway Infrastructure Planning & Design	3		-	3	3	40	60	3
6.6	PE 606 CE	Finite Element Methods	3		-	3	3	40	60	3
6.7	PE 604 CS	Deep Learning	3		-	3	3	40	60	3

OPEN ELECTIVE-I (BE VI Semester)

S.No	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
			3	**-**	**-**	**3**	**3**	**40**	**60**	**3**

LIST OF OPEN ELECTIVES I BE VI Semester

1) OE 601 BM Engineering Applications in Medicine
2) OE 602 BM Human Assistive Technologies
3) OE601 CE Disaster Management
4) OE 602 CE Road Safety Engineering
5) OE 601 EC Verilog HDL
6) OE 602 EC Principles of Electronic Communication Systems
7) OE 601 ME 3D Printing Technology
8) OE 602 ME Finite Element Method
9) OE 601 EE Applications of Electrical Energy
10) OE 602 EE Electrical Safety Management
11) OE 601 CS Python Programming
12) OE 602 CS Cyber security

V SEMESTER

PC501 CE	SOIL MECHANICS					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	Introduction of Particulate Mechanics further to the solid and fluid mechanics
2.	Characterization and classification of soils based on laboratory and field experiments
3.	Understanding of seepage, strength and compressibility characteristics of soils and learn the analysis of applications involving them.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understanding of soils as a three-phase particulate medium. Ability to determine theindex properties and based on them, ability to identify and classify the soils.
CO-2	Learn the seepage characteristics of soils and gain competence in seepage analysis.
CO-3	Gain knowledge of compressibility characteristics of the soils through compaction andconsolidation processes. Gain competence to conduct the laboratory tests, analyze and apply these processes.
CO-4	Learn shear strength characteristics of soils and gain competence to conduct the laboratory tests, analyse and apply these processes.
CO-5	Ability to compute earth pressure, evaluation of stability of slopes. Adequate preparation for learning the analysis and design of foundation systems to be taught in the following semester

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	2	2									2	2	2
CO2	2	2		3	2				3	3				
CO3	2	2		3	2	3								2
CO4	3			2	2	3			2	2	2		2	2
CO5	2	3			3	2	1	1			1	2	3	2
Avg	**2.4**	**1.8**	**0.4**	**1.6**	**1.8**	**1.6**	**0.2**	**0.2**	**1**	**1**	**0.6**	**0.8**	**1.4**	**1.6**

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT - I

Origin & Classification of Soils: Soil as a pseudo-elastic three phase particulate medium

Physical Properties of soil: Weight ratios (Water content, Density, Unit weights, Specific Gravity); Volume ratios (void ratio, porosity, degree of saturation, relative density); Inter relationships, Laboratory tests for determination of Index properties. Classification and Identification of soils for general and engineering purposes as per IS: 1498-1970.

UNIT - II

Soil Moisture States: Held and Free moisture-Capillarity in Soils: Surface tension and capillary rise in soil, Capillary tension, Capillary pressure. pF value.

Permeability of Soils: Darcy's law for flow through soils - validity of Darcy's Law - Factors affecting permeability - Laboratory tests for determination of co-efficient of permeability (constant head, variable head permeability tests) - Field tests (Pumping in and pumping out tests) - Equivalent permeability of stratified soils.

Seepage in Soils: Seepage flow, seepage pressure - Flow nets - Locating phreatic line in a homogeneous earthen dam using Kogeny's parabola - Computation of seepage quantity.

Stress in Soils: Total, effective and neutral stress distribution in different ground conditions

Quick Sand phenomena: Critical Hydraulic gradient, Remedial measures.

UNIT - III

Compaction Process: Compaction Mechanism; factors affecting compaction. Laboratory determination of compaction characteristics - standard and modified Proctor tests - IS Light and Heavy compaction tests; Field surface compaction: compaction equipment, procedure, quality control.

Consolidation Process: Spring analogy - Void ratio and effective stress (e Vs log p) relationship - Terazaghi's theory of one dimensional consolidation - Assumptions and derivation of GDE- Computation of magnitude of settlement (using Cc, mv) and rate of settlement (cv , Tv, d) classification based on OCR.

UNIT - IV

Shear Strength: Significance of Shear strength in soils - Mohr - Coulomb equation - shear parameters - Laboratory tests for determination of shear strength - Direct shear test, Tri-axial compression test, Un-confined compression test, Vane shear test, Factors affecting shear strength of cohesion-less and cohesive soils.

UNIT - V

Earth Pressure: States of earth pressure - Active, passive, at rest condition; Rankine's theory: Computation of active and passive earth pressure in c-less and cohesive soils; Coulomb's Wedge theory: Rehbhan's graphical solution: stability of earth retaining gravity wall.

Slope stability: Definition and classification of slopes -types of slope failure - Factors of safety with respect to cohesion, angle of shearing resistance, Height - Analysis of stability of slope using Swedish slip circle method and Taylor's stability number.

Suggested Readings

1	Lambe, T.W. and Whitman, R.V., "Soil Mechanics – SI Version ", John Wiley & Sons Inc., NY, 2011.
2	Alam Singh, Soil Engineering in Theory and Practice, Asia Publishing House,1981.
3	Venkataramaiah, C., “Geotechnical Engineering”, New Age Publishers, 2006
4	Murthy, V.N.S., "Soil Mechanics and Foundation Engineering". Dhanpat Rai & Sons, 2006.
5	Arora, K.R., "Soil Mechanics and Foundation Engineering", Standard Publishers Distributors, revised and enlarged sixth edition, 2007.
6	Das, B. M., “Advanced Soil Mechanics”, Taylor and Francis. 7 th Edition (2008)
7	Relevant Codes

PC502CE	WATER RESOURCES ENGINEERING-I					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	Providing awareness about water rights and water management principles
2.	Providing Knowledge regarding the fixation gravity dams dimension and fixing various levels in reservoirs
3.	Imparting basic concepts of planning for hydro power projects

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Ability to design and fix up reservoir systems and levels.
CO-2	Understand Gravity principle for design of dams.
CO-3	Capability to understand the seepage through Earthen dams.
CO-4	Understand various failure of tank systems and also ability to design
CO-5	Comprehend various components of Hydro power stations

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	2	3	3	1		2		1	3	1	1	3	1
CO2	1		1	1	1		2		1	2	1	1	1	1
CO3	3	2	3	3	3		1		1	2	1	1	2	1
CO4	3	2	3	3	1		2		1	3	1	1	2	1
CO5	2	1	2	3	1		2		1	3	1	1	2	2

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT - I

Water Resources Projects: Single and multipurpose projects, general principles of irrigation water rates, components of water allocation systems, riparian rights, groundwater rights, environmental and water quality management aspects of reservoir system operations.

Storage works: Purpose, selection of site, zones of storage, computation of storage capacity, fixation of different levels of reservoirs (LWL, FRL, MWL), evaporation reduction techniques.

UNIT - II

Dams: Classification of dams, selection of site for a dam, physical factors governing the selection of types of a dam.

Gravity dams : Forces acting on a gravity dam, modes of failure and criteria for structural stability of gravity dams, principal and shear stresses, gravity method of stability analysis, elementary and practical profiles of a gravity dam, high and low gravity dams, functions, and types of galleries in gravity dams, foundation treatment for gravity dams.

UNIT - III

Earth dams: Types of earth dams, causes of failure of earth dams, criteria for the safe design of an earth dam, computation of seepage from flow net, phreatic line in an earth dam (for homogeneous sections with and without filter cases), design of earth dams to suit available materials, embankment and foundation seepage control measures.

UNIT - IV

Tank irrigation: Types, site selection, causes for the failure of tank weirs, design of tank weirs, and general specifications for the construction of tank weirs.

Spillways: Different types of spillways, energy dissipation below spillways, different types of spillway crest gates, stilling basin appurtenances (descriptive details only).

UNIT - V

Hydro-power: Comparison of hydro power with thermal power, classification of hydro power plants, definition of various terms, principal components of hydro-electric power plants (Forebay, intake structure, penstock & surge tank), economical diameter of penstock.

Power house: Substructure and super structure of a power house, merits and demerits of an underground power house, fixation of dimensions of a power house.

Suggested Reading:

1.	Wurbs, R A. and James, W.P., *Water Resources Engineering*, Prentice-Hall of India, New Delhi, 2002.
2.	U.S. Bureau of Reclamation, *Design manual for concrete gravity dams*, Denver, 1976
3.	U. S. Army Corps of Engineers, *Engineering and Design*, CECW-ED Publication, 1995
4.	Punmia B.C. and Pande Lal B.B., *Irrigation and Water Power Engineering*, Lakshmi Publishers, 1993.
5.	Garg *S.K., Irrigation Engineering and Hydraulic Structures*, Standard Book House, 2010
6	M.M. Dandekar and K.N. Sharma, "*Water Power Engineering* 2nd Edition, Vikas Publishing House, Noida, U.P. 2013
7	R.K. Sharma and T.K. Sharma "*A Text book of Water Power Engineering*, S. Chand and Company Pvt. Ltd, New Delhi, 2016

PC503CE	THEORY OF STRUCTURES-I					
Pre-requisites	Basic Knowledge of Engg Mechanics		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understand basic methods for the analysis of statically indeterminate beams and frames using various displacement methods
2	To analyse the beams for displacements due to sinking of supports by various displacement methods
3	To evaluate bending moment and shear forces for Three Hinged and Two hinged arches under different Loading Conditions
4	To evaluate bending moment and Shear force of Multi Storied Frames subjected to Vertical loads.
5	To evaluate bending moment and Shear force of Multi Storied Frames subjected to Horizontal loads using various methods.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	To determine displacement for Beam and Portal Frame with and without sinking support using Slope Deflection Method.
CO-2	To determine bending moment and shear force for Beam and Portal Frame with and without sway using Moment Distribution Method
CO-3	To determine displacement for beam and Portal Frame with and without sway using Kani's Method.
CO-4	Analyze and sketch bending moment and shear force for three hinged and two hinged arches
CO-5	To analyze multi storied frames using approximate methods for vertical and horizontal loads and sketch bending moment and shear force

Articulation matrix of Course outcomes with PO's:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO 2**
CO1	3	2	1	2	1	-	-	1	1	1	-	2	1	-
CO2	3	2	1	2	1	-	-	1	1	1	-	2	1	-
CO3	3	2	1	2	1	-	-	1	1	1	-	2	1	-
CO4	3	2	1	2	1	-	-	1	1	1	-	2	1	-
CO5	3	2	1	2	1	-	-	1	1	1	-	2	1	-

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT - I

Slope Deflection Method: Application of the method to continuous beams with and without sinking of supports, single bay - portal frames (Degree of freedom not exceeding three), loading on each span may be point load(s) or uniformly distributed load on whole span, shear force and bending moment diagrams.

UNIT - II

Moment Distribution Method: Application of the method to continuous beams with and without sinking of supports, portal frames (static indeterminacy not exceeding three), loading on each span may be point load(s) or uniformly distributed load on whole span, shear force and bending moment diagrams.

UNIT - III

Kani's Method: Application of the method to continuous beams with and without support sinking, portal frames (static indeterminacy not exceeding three), and loading on each span may be point load(s) or uniformly distributed load on whole span, shear force and bending moment diagrams.

UNIT - IV

Approximate Method of Analysis.

Multi-storied building frames: Analysis due to vertical loads by substitute frame method – Analysis due to lateral loads by portal method, cantilever method and factor method.

UNIT - V

Elastic Theory of Arches: Eddy's theorem, three hinged parabolic and segmental arches, determination of horizontal thrust, bending moment, normal thrust and radial shear for static loading,C

Two hinged arches: parabolic and segmental, determination of horizontal thrust, bending moment, normal thrust and radial shear for static loading

Suggested Reading:

1.	D.S. Prakash Rao, *Structural Analysis- A Unified Approach*, University Press, 1999
2.	B.C. Punmia and A.K. Jain, *Theory of structures*, Laxmi Publications, New Delhi, 2004
3.	Pandit, G .S., S. P. Gupta and R. Gupta, *Theory of Structures*, Vol.l, Tata McGraw Hill, New Delhi, 1999.
4.	S.B. Junarkar, *Mechanics of Structures* (Vol. 1 &2), Charotar Publishing House Anand, 1992.
5.	C.S.Reddy, *Basic Structural Analysis*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi
6	Vazirani & Ratwani , *Analysis of structures* – Vol. I & II Khanna publications

PC504CE	DESIGN OF STEEL STRUCTURES					
Pre-requisites	Mathematical Knowledge		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	Know the IS codal provisions as applicable for the designs.
2.	Understand the material behavior and basics of design of steel structures.
3.	Learn the design of various members along with the connections.
4.	Know the design principles of roof trusses.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Acquire knowledge of IS codal provisions and design of different types of connections.
CO-2	Able to design any type of tension members.
CO-3	Competent to design various kinds of compression members and column bases.
CO-4	Capable to design different types of beams
CO-5	Proficient to design any type of roof trusses

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	3	3	3		3		3	3	3	2	3	3	3
CO2	3	3	3	3		3		3	3	3	2	3	3	3
CO3	3	3	3	3		3		3	3	3	2	3	3	3
CO4	3	3	3	3		3		3	3	3	2	3	3	3
CO5	3	3	3	3		3		3	3	3	2	3	3	3

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT-I:

Materials and Specifications: Chemical composition of steel, types of Structural Steel, Residual stresses, Stress Concentration. **Basis of Structural Design**: Codes and Specifications, Design Philosophies, working Stress Method, Limit State Method.

Loading and Load Combinations**:** Characteristic Loads, Dead Loads, Imposed Loads, Earthquake Loads, Wind Loads and Load Combinations. Partial safety factors for materials and loads.

Bolted Connections (Limit state method): Bolted Connections, Behavior of Bolted Joints, Design Strength of Ordinary Black Bolts, Design Strength of High Strength Friction Grip Bolts, Pin Connections, Simple Connections and Eccentric Connections.

Welded Connections (Limit State Method): Advantages of Welding, Types of Welds and Joints, Simple Connections and Eccentric Connections.

UNIT-II

Design of Tension Members (Limit State Method): Types of Tension Members, Design of Strands, Slenderness Ratio, Modes of Failure, Factors Effecting Strength of Tension Members, Design of Tension Members (Angles, Other sections and Rods), Lug Angles, Tension Member Splice.

UNIT-III

Design of Compression Members (Limit state method): Introduction, Possible Failure Modes, Behavior of Compression Members, Elastic Buckling of Slender Compression Members, Behavior of Real Compression Members, Sections of Compression Members, Effective Length, Design of Compression Members with Single Section and Built-up Sections (Symmetric in both directions), Lacing and Battening, Column Splices. Design of Column Bases (Limit state method): Design of Slab Base and Gusseted Base for Columns.

UNIT-IV

Design of Beams (Limit state method): Types of Beams, Section Classification, Lateral Stability of Beams, Buckling of Real Beams, Behavior of Beams in Bending, Design of Laterally Supported and Unsupported Beams, Design of Compound Beams, Shear Strength of Beams, Maximum Deflection, Web Buckling and Web Crippling, Biaxial Bending and Unsymmetrical Bending.

UNIT- V

Design of Roof Trusses (Limit state method): Types of Trusses, End Bearings, Spacing of Trusses and Purlins, Estimation of Loads with different Roof Coverings, Self-weight of Truss, Wind Effects, Design of Purlins for Dead Load, Imposed Load and Wind Loads. Detailed Design of Roof Trusses including Joints and Supports (only Angular Trusses).

Suggested Reading:

1.	Subramanian. N, *Design of Steel Structures*, Oxford University Press, 2008
2.	Duggal S.K., *Design of Steel Structures*, Tata McGraw Hill Publishing, 2009.
3.	Shiyekar M.R., *Limit State Design in Structural Steel*, PHI Learning Pvt. Ltd., 2010.
4.	Bhavikatti, S.S., *Design of Steel Structures*, I.K. International Publishing House Pvt. Ltd. 2010.
5	Gambhir M.L., *Fundamentals of Structural Steel Design*, McGraw Hill Education, 2013.
6	IS : 800 - 2007, *General Construction In Steel - Code of Practice*, Bureau of Indian Standards, New Delhi.
7	IS : 875 (Part 1) – 1987, *Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Part 1 Dead Loads - Unit Weights of Building Materials and Stored Materials*, Bureau of Indian Standards, New Delhi.
8	IS : 875 (Part 2) – 1987, *Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Part 2 Imposed Loads*, Bureau of Indian Standards, New Delhi.
9	IS : 875 (Part 3) – 2015, *Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Part 3 Wind Loads*, Bureau of Indian Standards, New Delhi.
10	IS : 875 (Part 4) – 1987, *Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Part 4 Snow Loads*, Bureau of Indian Standards, New Delhi.
11	IS : 875 (Part 5) – 1987, *Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Part 5 Special Loads and Combinations*, Bureau of Indian Standards, New Delhi.
12	IS : 1893 (Part 1) – 2016, *Criteria for Earthquake Resistant Design of Structures, Part 1 General Provisions and Buildings*, Bureau of Indian Standards, New Delhi.

PC505CE	TRANSPORTATION ENGINEERING					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Emphasize the significance of geometric design of highways with specifications and standards
2	To describe basic techniques for collecting and analysing traffic data, diagnosing problems.
3	To impart knowledge on pavement materials
4	Create awareness on Flexible pavement design
5	Impart knowledge on Rigid pavement design

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Assimilation of the various concepts of Highway geometric design
CO-2	Application of concepts related to traffic engineering
CO-3	Knowledge related to selection of pavement materials
CO-4	Able to design flexible pavements
CO-5	Analyze and Design the rigid pavements

CO-PO Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO 2**
CO1	2	3	2	1	2								2	
CO2	2	2	2	2	2								3	1
CO3	2	2	3	1	1		2					1	2	2
CO4	2	2		1	2		2				2		3	2
CO5	2	2	2	1	2		2				2	1	1	2

Correlation rating: Low/ Medium/High:1/2/3respectively.

UNIT-I

Highway development and planning-Classification of roads, road development in India, Current road projects in India; highway alignment and project preparation.

Geometric design of highways- Introduction; highway cross section elements; sight distance, design of horizontal alignment; design of vertical alignment; design of intersections, problems

UNIT-II

Traffic Engineering & control- Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control; Type of road markings & Signs; design of signals,

capacity analysis and design of rotary intersections, parking facilities; accident studies; highway lighting; problems.

UNIT-III

Pavement materials- Materials used in Highway Construction; desirable properties, tests, requirements for different types of pavements: Soils, Stone aggregates, bituminous binders, bituminous paving mixes, introduction to Marshall Mix method; Portland cement, types of cement concrete: desirable properties, tests on cement and hardened concrete, requirements for different types of pavements; problems.

UNIT IV

Flexible Pavements-Types of pavements and factors affecting design of flexible pavement, performance; stresses in flexible pavements; design of flexible pavements as per IRC:37-2018; Surface and Sub-surface drainage systems, Thickness design problems. Distresses in flexible pavement, causes and performance indicators.

UNIT-V

Rigid pavements- Components and functions; factors affecting design stresses in rigid pavements; types of joints, design of concrete pavements as per IRC:58-2015; Design of dowel bars and tie bars, Distresses, causes and performance of CC pavements. Design problems.

Suggested Reading:

1.	Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017
2.	Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski,'Principles of Highway Engineering and Traffic Analysis', 4th Edition, John Wiley
3.	Paul H. Wright and Karen K. Dixon, Highway Engineering, 7th Edition, Wiley Student Edition, 2009.
4.	Kadiyali, L.R, Lal N.B, 'Principles and Practices of Highway Engineering' Khanna Publishers, 2013
5.	IRC: 37 (2018), 'Guidelines for the design of flexible pavements', Indian Roads Congress, New Delhi
6.	IRC: 58 (2015), 'Guidelines for the design of plain jointed rigid pavements', Indian Roads Congress, New Delhi

Professional Electives –II

PE501CE	RETROFITTING AND REHABILITATION OF STRUCTURES					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student :	
1.	Understand the basic concepts of repairs, maintenance, cracks and deterioration of structures
2.	Know the causes of corrosion in RC structures.
3.	Understand and learn the corrosion mechanism in steel structures
4	Diagnosis the evaluation of repair techniques in masonry structures
5	Learning the principle of retrofit and rehabilitation techniques.

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Diagnosis the suitable repair and suggest methods to repair of cracks in structures.
CO-2	Identify repair problems and undertake global and local retrofit techniques for RC structures & prevent deterioration ofR C structures
CO-3	Arrive at the repair solutions &diagnosis and suggest methods to prevent deterioration of steel structures
CO-4	Diagnosis and suggest methods to prevent deterioration ofMasonry structures
CO-5	Identify and suggest methods to Strengthen of Existing Structures by mean of high level retrofit techniques

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	3	2	3	3	2	3	3	3	2	2
CO2	3	2	2	3	2	2	2	3	3	3	3	2	2	2
CO3	2	3	2	2	3	2	3	3	2	3	3	3	1	2
CO4	2	3	3	3	3	2	3	3	3	3	3	2	2	3
CO5	3	3	3	2	2	2	3	2	2	3	3	3	2	3

Correlation rating: Low/ Medium/High: 1/2/3 respectively.

UNIT - I

Introduction - Need for study, types of maintenance, routine maintenance works in buildings, inspection, structural appraisal, economic appraisal, general causes of deterioration, general steps for repair and rehabilitation.

Cracks in Buildings - Cracks due to moisture changes, thermal variations, elastic deformation, creep, chemical reactions, foundation settlement and vegetation, diagnosis and repair of cracks.

Moisture Penetration - Sources and effects of dampness, reasons for ineffective damp proof course, remedies for damp masonry walls, leakage of RCC roofs and pitched roofs, causes and remedial measures, Ferro cement overlay, chemical coatings, flexible and rigid coatings.

UNIT - II

Reinforced Concrete Structures - Causes of deterioration, diagnosis of causes, corrosion of reinforcement and its control, repair of cracks, repair of spalling and disintegration, repair of floors and pavements, conventional methods of repair, special methods, use of polymers, epoxy resins, classification of retrofit techniques – global and local retrofit methods.

UNIT - III

Steel Structures - Causes and types of deterioration, mechanism of corrosion, prevention of deterioration, influence of design details, design and fabrication errors, stresses due to erection, methods of repair, plating.

UNIT – IV

Masonry Structures - Causes of deterioration, biocidal treatment, preservatives, repair of crack in masonry walls, mortar joint repair, and removal of stains from masonry walls, classification of retrofit techniques – global and local retrofit methods.

UNIT – V

Strengthening of Existing Structures - Relieving existing load, strengthening of superstructure, conversion to composite construction, post stressing, jacketing, bonded overlays, addition of reinforcement, strengthening of substructure, underpinning, design for rehabilitation.

Suggested Reading:

1.	Johnson.S.M., (1980), Deterioration, Maintenance and Repair of Structures, Krieger Publishing, Melbourne, Florida.
2.	Guha. P.K., (1998), Maintenance and Repairs of Buildings, New Central Book Agency Ltd., Kolkata.
3.	SP: 25-1984, (1999), Handbook on Causes and Prevention of Cracks in Buildings, BIS, New Delhi.
4.	Richardson. B.A., (1980), Remedial Treatment of Buildings, Construction Press, London
5.	Chudley. R., (1981), The Maintenance and Adaptation of Buildings, Longman Group Ltd., New York.
6.	Agarwal. P., and Shirkhande.M., (2006), Earthquake Resistant Design of Structures, Prentice Hall India, New Delhi.
7.	Mac Donald.S, (2003), Concrete – Building Pathology, Blackwell Science Ltd.,

PE 502 CE	APPLIED HYDROLOGY					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1.	Introduction to the basic concepts and consciousness about flood characteristics and its forecasting systems
2.	Inputs on engineering principles and mathematics of Flood routing
3.	Awareness about the Flood mitigation, its adjustment, and possible regulations
4	Knowledge on application of Hydrological time series analysis

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Application of mathematics of flood forecasting and flood routing as well as adaptation of policy criteria for flood control
CO-2	Aptitude to apply flood routing techniques in a regime
CO-3	Capacity to adopt various flood mitigation measures
CO-4	Propensity to employ flood plain adjustments and other techniques for flood management.
CO-5	Skill to analyze hydrologic time series for water resources applications

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	2	2	2		2		2	3	2
CO2	3	3	3	1	2	1	2	2	1	2		2	2	1
CO3	3		2	2	1	1	3	2	2	1		2	2	2
CO4	2	2	2		1	2	2	1	2	2	1	2	1	2
CO5	2	1		2	3	2	1	2		2	2	3	2	2

Correlation rating: Low/ Medium/High: 1/2/3 respectively

UNIT-I

Flood characteristics and forecasting: Measurable features of a flood (Elevation, discharge, volume, and duration), operation of flood forecasting systems, Flood forecasting (unit hydrograph method, meteorological and snow data, and snow field air temperatures)

Space-time characteristics of rainfall - reservoir, spillways, diversion dams and barrages, design flood criteria for dams and other hydraulic structures (CWC recommendations). Policy criteria for design flood of a major

and minor

UNIT – II

Flood routing: Introduction, Mathematics of flood routing, various methods of flood routing, Hydrologic routing and its applications, Hydraulic routing and its applications

UNIT – III

Flood mitigation: Flood mitigation reservoirs - purpose, location, size and operation, Levees and flood walls (location, maintenance and flood fighting), flood ways, Channel improvement, evacuation and flood proofing, land management, Flood plain management, estimating benefits of flood mitigation

UNIT-IV

Flood plain adjustments and regulations: Results of controlling floods, alternatives to controlling flood, Range of possible adjustments, practical range of choice, critical characteristics of flood hazards, Classification of flood plain land and regulation of flood plain use.

River training works - guide banks, approach and afflux embankments, spurs / Groynes, artificial cut-off, bank protection, pitched banks, and miscellaneous methods. Numerical problems

UNIT-V

Hydrologic Time Series Analysis: Independent and Auto-correlated data, structure of hydrologic time series, trend, jump, seasonality, stationarity, Auto-covariance and Auto-correlation Function, Correlogaram Analysis, spectral Analysis, Analysis of Multi-Variant Hydrologic series.

Suggested Reading:

1.	Ven Te Chow (1964), Hand Book of Applied Hydrology', McGraw-Hill Publishers, New York.
2.	Linsley, R. K. and Franzini A. W. (1992), Water Resource Engineering' McGraw-Hill Publishers, New York
3.	Varshney, R. S. (1979), 'Engineering Hydrology', Nem Chand Publishers, Roorkee.
4.	Jaya Rami Reddy, P. (1987), 'A. Text Book of Hydrology', Lakshmi Publishers, New Delhi
5.	Daniel H. Hoggan (1989), Computer Assisted Flood Plain Hydrology and Hydraulics', McGraw-Hill Publishers, New York.

PE 503 CE	ADVANCED DESIGN OF CONCRETE STRUCTURES					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1.	Understand the design procedures for columns and footings.
2.	To know the design and detailing of flat slab and ribbed slab.
3.	Understand the design procedures and detailing of retaining walls.
4.	To be able to design the different types of water tanks.
5.	Be able to understand the IRC Loadings for design of bridges.

Course Outcomes	
On completion of this course, the student will be able to:	
1.	Design columns and footing as per IS specifications
2.	Design and detail flat and ribbed slabs for given loads.
3.	Design retaining walls and check the stability of the same.
4.	Design different types of water tanks
5.	Design and evaluate the loads on bridges based on IRC codes

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	2	1	1	1	-	1	2	1	-	1	-	2	-	-
CO2	2	2	2	2	-	2	2	1	1	1	-	2	-	-
CO3	2	1	2	2	2	1	2	1	1	1	-	2	-	-
CO4	2	2	2	1	1	1	2	1	1	1	-	2	-	-
CO5	2	2	2	2	1	1	2	1	1	1	-	2	-	-

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT - I

Introduction to Columns and footings, Definition, IS codes. Elastic design and detailing of combined rectangular footings.

UNIT - II

Design of Ribbed slabs and Flat slabs: Introduction to ribbed and flat slabs, Analysis of the Slabs for Moment and Shears, Ultimate Moment of Resistance, Design for shear, Deflection, Arrangement of

Reinforcements. Flat slabs: IS specifications and general notes on flat slabs Direct design method – Distribution of moments in column strips and middle strip-moment and shear transfer from slabs to columns – Shear in Flat slabs-Check for one way and two way shears – Introduction to Equivalent frame method. Limitations of Direct design method, Distribution of moments in column strips and middle strip.

UNIT - III

Retaining Walls-the different types of Retaining Walls. Proportioning the retaining walls Determining the Lateral earth pressure on Retaining walls. Perform the Stability checks: overturning, sliding, bearing capacity, and settlement. Elastic design and detailing of retainingwalls-cantilever and counter fort types.

UNIT - IV

Types of water tanks, Definition, IS codes. Elastic design and detailing of rectangular and circular, ground and overhead tanks including Intze tanks. Design of staging.

UNIT - V

Bridges: Introduction to Bridges, Classification of Bridges, Recent advances in Bridge Engineering,. IRC loading – impact factor – effective width method and Pigeaud‟s method. Elastic design and detailing of (i) R.C. Slab bridges and (ii) T-beam bridges for IRC loadings.

Suggested Reading:

1.	Krishna Raju, N. (2009). “Structural Design and Drawing (third Edition).” Universities press
2.	Punmia, B. C., Jain, A.K and Jain, A. K. (2006). “RCC designs (Reinforced concrete structures). Laxmi publications (10th edition).
3.	Phatak,(1990). “Bridge Engineering.” Satya Prakashan Publishers.
4.	Johnson D. Victor. (2006). “Essentials of Bridge Engineering.” Oxford &IBH Publishers, Pvt.Ltd., New Delhi.
5.	IS: 456: 2000, Code of Practice for Plane and Reinforced Cement Concrete.
6.	SP 16, SP 34- & IS 3370 Part I to Part IV.

PE 504 CE	AIRPORT ENGINEERING					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Understand basic terminology, development plans and standards relate Airport Engineering.
2	Understand the various components of airport and runway components.
3	Provide details of various geometric standards and design of flexible pavement of runways
4.	Provide details of analysis and design elements related to rigid runway pavements
5.	Study airport layout plans for installation of various types of devices pertaining to Air Traffic Controls and visual aids.

Course Outcomes : Completion this course, students will be able to	
CO-1	Understand the concepts related to airport planning and development.
CO-2	Conduct surveys, develop and design new airports with ICAO/FAA geometric standards.
CO-3	Able to conduct analysis and design elements related to flexible runway pavements
CO-4	Able to conduct analysis and design elements related to rigid runway pavements
CO-5	Develop plans for installation of various types of devices pertaining to Air Traffic Controls and visual aids.

CO-PO Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	2	2	2	2	1		2		1	1	1	1	1	
CO2	2	2	1	1	1		2		1		1		1	
CO3	2	2	2	2	1		1				1		1	
CO4	2	2	2	1	2						1		1	
CO5	2	1	1											

UNIT- I: **Airport Planning:** Growth of Air Transport, Technological Developments, Institutional Development for Planning, Regulatory Practices; Aircraft characteristics related to airport planning and design, Future trends in Air craft design and Airport Planning; Airport master plan, site selection, planning surveys etc. Airport Obstructions: Zoning Laws, Classification, Approach and Turning Zones.

UNIT- II: **Runway Design and Airport Capacity:** Runway Orientation, Basic Runway Length and Factors affecting, Correction for elevation, temperature and gradient as per ICAO and FAA, Run way Geometric Design. Airport Capacity: Classification and Standards; Capacity of Airport, Runway; Configuration of Airport and Configuration; Runway Intersection Design; Terminal Facilities and Standards: Planning Concepts. Overview of Geometric Design as per ICAO.

UNIT-III: **Flexible Airport Pavement Design:** Design factors, Calculation of ESWL with different wheel load configurations and methods, Repetition of loads, failure criteria; Flexible Pavements Design: US corps of Engineers Method, FAA method; Drainage: Surface and subsurface methods, Airfield Pavement Maintenance and Rehabilitation: Need, Failures, Evaluation of flexible pavements, Maintenance operations.

UNIT- IV: **RIGID Airport Pavement Design:** Design factors, US corps of Engineers method, PCA Method, FAA method, LCN Method and CAN-PCN System.; Overlays; Drainage: Surface and subsurface methods, Airfield Pavement Maintenance and Rehabilitation: Need, Failures, Evaluation of Rigid Pavements, Maintenance operations.

UNIT- V: **Air Traffic Controls (ATC):** Visual Aids: marking and lighting; Need, Network and Aids for ATC, Radio equipment; Design of Heliports and STOLPORTS: Design Factors, Planning, Site selection. Geometric Designs, Visual Aids. Visual Aids: marking and lighting; Need, Network and Aids for ATC, Radio equipment;

Suggested Reading:

1.	Yoder E.J. and Witczak M, Principles of Pavement Design,. W.John Wiley &-Sons, 1975.
2.	Srinivasa Kumar R, Transportation Engineering (Railways, Airports, Docks &Harbours), Universities Press, 2014.
3.	Planning and Design of Airports, Robert Horojeff, McGrawHill Book Co. 1977
4.	Air Port Engineering, Norman Ashford and Paul H Wright, M.W.JohnWHey& Sons. 1987
5.	Airport Planning and Design, S.K. Khanna, Arora and S.S. Jain,Nem Chand & Bros. Roorkee. 1986.

PC551CE	SOIL MECHANICS LABORATORY					
Pre-requisites			**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	50 Marks	**CIE**		25 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student	
1.	Expose the students to different types of soils
2.	Experience the concepts of soil mass, soil solids, and soil structure.
3.	Understand the laboratory test procedures and appreciate the suitability of each test.
4	Make the students to relate theoretical concepts in doing lab tests.

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Ability to process soil sample and prepare test specimen simulating the in-situconditions
CO-2	Competence to launch the specimen, fix the instrumentation, perform the test and to record the observations
CO-3	Ability to analyses the data, find the test results, make critical observation on appropriateness of the result and its application
CO-4	Greater insight in to the soil behavior and hence enhanced understanding of soil mechanics
CO-5	Ability to model a field application in the laboratory to take up research

Articulation matrix of Course outcomes with PO's:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO 2**
CO1	2		1	2	2				2			1	2	2
CO2			1	1	3				3			2	2	2
CO3	3	3		2	2	1		1		2		1		2
CO4	2		2	2			2			2	1	1		1
CO5	2	2	2	3	2	1	2	2		2	2	2	3	3

Correlation rating: Low/ Medium/High:1/2/3respectively.

List of Experiments:

I. DETERMINATION OF INDEX PROPERTIES:

Determination of

1. Specific Gravity of soil solids using
    a. Density bottle method
    b. Pycnometer method
2. Water content using
    a. Oven drying method
    b. Pycnometer method
3. Liquid and Plastic limit
4. Sieve Analysis
5. Classification of Soils as per IS:1498-1970
6. Field Density using Sand Replacement Method

II. DETERMINA TION OF ENGINEERING PROPERTIES:

Determination of

7. Compaction Characteristics using
    a. IS Light Compaction Test
    b. IS Heavy Compaction Test
    c. Compare and find the effect of Compaction Effort on Compaction mechanism
8. Co-efficient of Permeability by
    a. Constant Head Permeameter test
    b. Variable Head Permeameter test
9. Shear strength parameters by
    a. Direct Shear Test
    b. Unconfined Compression Test
    c. Vane Shear Test
10. California Bearing Ratio (CBR) value

III. DEMONSTRATION OF TEST PROCEDURE:

11. Consolidometer test
12. Tri-axial compression Test
13. Laboratory Plate Load Test
14. Reverse Osmosis Test
15. Quick Sand Model
16. Cyclic Tri-axial Test Facility

Suggested Reading :

1. IS:2720 – Relevant Parts.
2. Lambe, T.W., "*Soil Testing for Engineers*", Wiley Eastern Ltd., New Delhi, 1969.

PC552CE	TRANSPORTATION ENGINEERING LABORATORY					
Pre-requisites	Transportation Engineering		**L**	**T**	**P**	**C**
			3	-	-	1
Evaluation	**SEE**	50 Marks	**CIE**		25 Marks	

Course Objectives:	
1	To study the basic tests on road aggregate
2	To study the basic tests on bitumen
3	Create awareness on traffic studies

Course Outcomes :	
CO-1	Assimilation of the various concepts of Pavement Materials
CO-2	Understanding and application of test on road aggregates
CO-3	Knowledge related to selection of bituminous binders
CO-4	Able to solve the traffic related issues
CO-5	Knowledge on design bituminous mixes

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1											
CO2	2	3	2	2		2	1		1	2		1	1	
CO3	2	3	2	2		2	1		1	2		1	1	
CO4	2	3	3	3	2	2	2		3	2	1	1	2	2
CO5	2	1												

Correlation rating: Low/ Medium/High:1/2/3 respectively

A) **Tests on Bitumen:**

1) Penetration test
2) Ductility test
3) Softening point test
4) Specific Gravity test
5) Viscosity test,
6) Flash and Fire point test

B) **Tests on Aggregate:**

1) Aggregate Crushing test,
2) Los Angles Abrasion test,
3) Aggregate Impact test,
4) Shape test,
5) Specific gravity and Water Absorption,
6) Soundness

C) **Experiments on Traffic:**

1) Traffic Volume study
2) Spot speed study

3) Speed and delay study
4) Origin & Destination study

D) **Miscellaneous Tests (Demo):**

1) Marshall Stability,
2) Bitumen Extraction
3) Stripping test
4) DCP test

Suggested Reading:

1.	Khanna SK and Justo CEG, 'Highway material testing' (Lab manual), Nem Chand & Bros
2.	Relevant IS and IRC Codes of practice

SCHEME OF INSTRUCTION AND EVALUATION
B.E. (CIVIL ENGINEERING) Applicable w.e.f. 2024-25

BE VI – Semester

PC601CE	**ENVIRONMENTAL ENGINEERING**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	Introduction to the basic concepts and requirements of environmental engineering
2.	Knowledge about different sequential unit operations of water and wastewater treatment processes
3.	Inputs on engineering principles for analyzing various environmental issues
4	Awareness towards the sustainability of standards for water resources
5	

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Aptitude to plan for protected water supply system needs and requirements
CO-2	Ability to design sequential unit operations in water treatment plants
CO-3	Acquaintance with collection procedures and design of sewerage systems
CO-4	Capacity to design for the safe disposal of wastewater and its reuse
CO-5	Knack to analyze, execute and maintain standards for sustainable development of the society

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	2	2	2	--	--	1	3	3	3	2	2	2	3	2
CO2	3	2	2	1	1	2	3	2	1	2	2	2	1	2
CO3	2	--	2	--	3	1	2	2	1	1	1	1	3	1
CO4	2	1	2	1	1	2	1	1	--	1	1	2	2	1
CO5	2	1	3	--	2	1	3	1	2	2	1	2	1	3

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT-I

Water Supply: Need for planned water supply schemes, water demand for industrial and agricultural water requirements, Sources of water, standards and quality issues, water quality requirements for different beneficial uses, Population Forecast, water treatment through aeration, coagulation flocculation, and sedimentation.

UNIT – II

Water Treatment: Filtration, Disinfection, and Softening, methods of layout of distribution pipes, design of distribution by Hardy Cross method for simple networks, various types of pipes and valves used in water supply systems.

UNIT – III

Sewage: Domestic and Storm water, Quantity of Sewage, Sewage flow variations.
Conveyance of sewage: Sewers shapes, design of sewerage systems, operation and maintenance of sewers, sewage pumping, sewer appurtenances

UNIT-IV

River cleaning plans: Self-purification of streams, BOD and COD concepts, wastewater treatment, aerobic and anaerobic treatment system, suspended and attached growth systems, quality requirements of recycled water for various purposes. Principles of Septic Tank

UNIT-V

Advanced WWT concepts: Theory and design concepts of Activated Sludge Process, Mechanically Aerated Lagoons, Sequencing Batch Reactor (SBR), Waste Stabilization Ponds, basic concepts of Bio-Remediation**.**

Suggested Reading:

1.	Fair, G. M. and Geyer, J. C. *Water and Wastewater Engineering, vol. I and II*, John Wiley & Sons, Inc., New York, 1954
2.	Hammer, M.J. and Hammer, M.J. Jr., *Water and Wastewater Technology*, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998
3.	Metcalf & Eddy, *Wastewater Engineering, treatment, disposal, and reuse*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1995
4.	Gilbert, M. Masters., *Introduction to Environmental Engineering and Science*, Prentice-Hall of India Pvt. Ltd., New Delhi, 1995
5.	Norris, Robert, *Handbook of Bioremediation*, CRC Press, 1993
6	A. Pytel and F. L. Singer, *Strength of Materials*, Harper & Row, Fourth Edition, NewYork, 1987.

PC 602CE	THEORY OF STRUCTURES- II					
Pre-requisites	Theory of Structures-I		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	Understand the analysis of structural elements subjected to various types of moving loads
2.	To understand behavior of the suspension bridge and analyze for stresses along with suspension girder.
3.	To evaluate bending moment and shear forces of various structural elements using matrix method of analysis
4.	Illustrate the matrix methods of structural analysis for computer applications
5.	

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Sketch ILD for bending moment and shear force, for determinate girders for different position of loading system and for different sections of girder
CO-2	Analyze cable suspension bridges along with three hinged stiffening girder for static loads
CO-3	Analyze the redundant beams and frames Using Flexibility method
CO-4	Analyze redundant members using direct stiffness method
CO-5	Calculate the bending moment and shear force and sketch the BMD and SFD for redundant members using force and displacement methods

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	2	1	2	1	-	-	1	1	1	-	2	1	-
CO2	3	2	1	2	1	-	-	1	1	1	-	2	1	-
CO3	3	2	1	2	1	1	1	1	1	1	-	2	1	-
CO4	3	2	1	2	1	1	1	1	1	1	-	2	1	-
CO5	3	2	1	2	1	1	1	1	1	1	-	2	1	-

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT - I

Moving loads: Influence line for support reaction, bending moment and shear force at any location for simple beams. Determination of maximum bending moment and shear force for moving load systems on simply supported girders.

Curves of maximum bending moment and shear force: for simply supported girders traversed by (l) single point load, (2) two point loads, (3) uniformly distributed-load longer/shorter than span, enveloping parabola and EUDLL

UNIT - II

Moving loads on trusses / girders: Influence lines for forces in members of statically determinate plane framed structures under moving loads for Warren girder, Pratt truss, and Curved flange truss.

Suspension bridges: Stresses in suspended loaded cables, length of cable, simple suspension bridge with 3-hinged stiffening girders for static load, Influence lines for horizontal and vertical components of tension in the cable, tension in the cable, bending moment and shear force.

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UNIT - III

Flexibility Matrix Method: Determination of Static and kinematic indeterminacy - Equilibrium and compatibility conditions-Principles of superposition, Application of Flexibility Matrix Method to continuous beams, plane trusses, plane frames and ortho grid structures (Static indeterminacy not exceeding three) - Effect of temperature, Lack of fit and Pre-stressing forces

.

UNIT – IV

Stiffness Matrix Method: Application of Stiffness Matrix Method to continuous beams, plane trusses, plane frames and ortho grid structures (Degree of freedom not exceeding three). Construction of stiffness matrix for frames - Direct Method

UNIT - V

Direct Element Method: Development of stiffness matrices for bar, truss and beam elements. Application of direct element method to problems of axially loaded bars, continuous beams, plane trusses and plane frames to obtain joint displacements and member end forces. Developing shear force and bending moment diagrams. Introduction to software package STAAD Pro

Suggested Reading:

1.	D.S. Prakash Rao, *Structural Analysis- A Unified Approach*, University Press, 1999
2.	B.C. Punmia and A.K. Jain, *Theory of structures*, Laxmi Publications, New Delhi, 2004
3.	Pandit, G .S., S. P. Gupta and R. Gupta, *Theory of Structures*, Vol.l, Tata McGraw Hill, New Delhi, 1999.
4.	P.N Godbole, R.S Sonparote, & S.U Dhote Matrix method of Structural Analysis PHI learning Private Limited , New Delhi 2014
5.	C.S.Reddy, *Basic Structural Analysis*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi
6	Thandavamoorthy , *Structural Analysis* – Oxford Higher Education,2011

PC 603CE	Structural Engineering Design and Drawing - I (CONCRETE)					
Pre-requisites	Theory of Structures-I		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	Learn and understand the design of columns and footings.
2.	Know the design and detailing of flat slabs and ribbed slabs.
3.	Understand the design process and detailing of retaining walls.
4.	Design the different types of water tanks.
5.	Understand the IRC Loadings for design of bridges

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Design columns and footing as per IS specifications
CO-2	Design and detail flat and ribbed slabs for given loads.
CO-3	Design retaining walls and check the stability of the same.
CO-4	Design different types of water tanks
CO-5	Design and evaluate the loads on bridges based on IRC codes

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	2	2	3	2	3	2	2	2	3	1	2	2	2
CO2	3	3	3	2	3	3	2	2	2	2	2	1	3	2
CO3	3	3	3	3	3	3	2	2	2	3	1	2	3	2
CO4	3	3	3	3	3	2	3	3	2	3	2	1	2	1
CO5	3	3	3	3	2	3	3	2	2	3	2	2	3	2

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT - I

Introduction to Columns and footings, Definition, IS codes. Elastic design and detailing of combined rectangular footings.

UNIT - II

Design of Ribbed slabs and Flat slabs: Introduction to ribbed and flat slabs, Analysis of the Slabs for Moment and Shears, Ultimate Moment of Resistance, Design for shear, Deflection, Arrangement of Reinforcements. Flat slabs: IS specifications and general notes on flat slabs Direct design method – Distribution of moments in column strips and middle strip-moment and shear transfer from slabs to columns – Shear in Flat slabs-Check for one way and two way shears – Introduction to Equivalent frame method. Limitations of Direct design method, Distribution of moments in column strips and middle strip.

UNIT - III

Retaining Walls-the different types of Retaining Walls. Proportioning the retaining walls Determining the Lateral earth pressure on Retaining walls. Perform the Stability checks: overturning, sliding, bearing capacity, and settlement. Elastic design and detailing of retaining walls-cantilever and counter fort types.

UNIT - IV

Types of water tanks, Definition, IS codes. Elastic design and detailing of rectangular and circular, ground and overhead tanks including Intze tanks. Design of staging.

UNIT - V

Bridges: Introduction to Bridges, Classification of Bridges, Recent advances in Bridge Engineering IRC loading – impact factor – effective width method and Pigeaud's method. Elastic design and detailing of (i) R.C. Slab bridges and (ii) T-beam bridges for IRC loadings.

Suggested Reading

1.	Krishna Raju, N. (2009). "Structural Design and Drawing (third Edition)." Universities
2.	Punmia, B. C., Jain, A.K and Jain, A. K. (2006). "RCC designs (Reinforced concrete
3.	Phatak (1990) "Bridge Engineering." Satya Prakashan Publishers.
4.	Johnson D. Victor. (2006). "Essentials of Bridge Engineering." Oxford &IBH Publishers,
5.	**Note:** All latest relevant IS codes necessary for teaching this course may be introducedand
6.	IS: 456: 2000, Code of Practice for Plane and Reinforced Cement Concrete.
7.	7. SP 16, SP 34.
8	IS 3370 Part I to Part IV

PC 604CE	FOUNDATION ENGINEERING					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	Learn the definition, necessity, types and suitability of different foundation systems.
2.	Understand the procedures of Geotechnical design of foundations
3.	Understand the necessity and usage of different foundation construction related aspects
4.	Learn about different methods of geotechnical investigations and its role in selection and design of foundations
5.	Learn the definition, necessity, types and suitability of different foundation systems.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Ability to compute distribution of increment in vertical stress in soil medium due toapplied loads using mathematical theories
CO-2	Competence to plan and perform Geotechnical Investigations to characterize the ground and ability to decide the ideal type of foundation.
CO-3	Competence to analye and estimate the safe bearing capacity of shallow foundations, to perform settlement analysis and to take up geotechnical design of shallow foundations
CO-4	Ability to analyze pile foundations and to estimate the carrying capacity of single andgroup of piles. Knowledge of Caissons, Machine foundations.
CO-5	Ability to practice Foundation Engineering with ethics and lifelong learning

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	2	2			2		1	2			2		2
CO2	2	2		3	2	2		1	3		2	2		2
CO3	3	2		3	2			2	2	1		2		2
CO4	3	2	2		3		2	2	3			2		2
CO5	3	3	3	3	2	2		2	2		2	2	2	3

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT - I

Stress distribution in Soils: Boussinesq‟s theory – Computation of increment in vertical stress due to

application of a point load (its distribution on horizontal, vertical planes), uniformly distributed circular and rectangular areas –Pressure bulb – Significant depth - Construction and use of Newmark‟s chart – Westergaard‟s theory – Validity of elastic theories – Contact pressure distribution.

UNIT – II

Introduction to Foundations: Functional requirements – types – differentiation of shallowand deep foundations – suitability

Safe Bearing Capacity of Shallow foundations: Definitions - (a) Based on theories – types of shear failures - Terazaghi‟s theory for safe bearing capacity of shallow foundations – Effect of type of shear failure / shape of the footing / water table – Provisions of IS : 6403-1981 (b) Based on field tests : Plate load test / Standard Penetration test.

Allowable bearing Capacity of Shallow foundations: Settlement Analysis – Total settlement – Elastic settlement – Consolidation settlement (ultimate & after any given period correction for construction period) – Permissible uniform & differential settlements –Proportioning of footings.

UNIT - III

Pile Foundations: Necessity – types based on load transfer mechanism / material / method of installation / functional use – Estimation of vertical load carrying capacity of a single pile – static formulae / Dynamic formulae / Pile load tests – Cyclic pile load test for separation of total capacity in to bearing and friction components – Pile groups – necessity – efficiency of Pile groups - estimation of group capacity – Settlement analysis of individual and group of Piles - Negative Skin friction – Concept of Piled raft foundation.

UNIT – IV

Caissons: Necessity – types – Essential components of open (well) / box (floating) / Pneumatic caissons - suitability – Sinking of caissons – correction for tilt & shift – Scour analysis – Fixing depth of Caisson – Provisions of IS:3955 and IRC:78.

Machine foundations: Differentiation with static foundations – vibration characteristics (frequency / amplitude/ resonance) – types of machines and machine foundations – additional design requirements

Geotechnical Investigations: Necessity – Principles of exploration - objectives – Soil profile – collection of disturbed & undisturbed soil samples – samplers & quality of samples - methods – Trial pit / Bore hole method – Log of bore hole details

UNIT – V

Foundation construction related aspects :

Timbered / braced excavations: Necessity - methods – suitability – distribution of pressure – reaction of struts.

Dewatering: Necessity – methods – sumps (ditches) / well point system (single /multi-stage) / deep well system / elector-osmonsis method – merits & demerits – suitability

Coffer dams: necessity – types – suitability

Underpinning: Necessity – methods (pin / pile) - suitability

Geosynthetics: Classification – functions – applications.

Suggested Reading:

1.	Bowles, E. (2012). "*Foundation analysis and Design*", McGraw-Hill Publications.
2.	Das, B.M. (2012). "*Principles of Foundation Engineering*", Sengrece Publications.
3.	Arora, K.R. (2012). "*Soil Mechanics*
4.	Verghese, P.C. (2012). "*Foundation Engineering*", PHI Publications.

PC 605CE	WATER RESOURCES ENGINEERING –II					
Pre-requisites	Fluid Mechanics -I		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1.	To provide design based on seepage theory for weirs and barrage structures
2.	To impart knowledge regarding the alluvium principles and silt theory in canals
3.	To describe design aspects of different types of canal regulatory systems

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Ability to design the design floor thickness based on seepage theory
CO-2	Understand creep theories and design components of diversion head works
CO-3	Capability to design canals based on Alluvium principles
CO-4	Understand importance and design aspects of canal falls
CO-5	Comprehend various components of cross drainage works

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	3	1		2		1	3	1	1	3	1
CO2	1	2	2	2	3		2		1	3	1	1	1	2
CO3	3	2	3	3	3		1		1	2	1	1	2	2
CO4	3	2	3	3	1		2		1	3	1	1	3	2
CO5	2	1	2	3	1		2		1	3	1	1	2	1

Correlation rating: Low/ Medium/High: 1/2/3 respectively

UNIT-I

Weirs: Components of diversion head works, types of weirs – fixation of still level of head sluice, scouring sluice and crest level of weir, afflux and top level of flood banks, design of vertical drop and sloping glacis weir, design for surface flow and sub - surface flow, length, level and thickness of downstream apron, upstream and downstream cutoffs, protection works.

UNIT – II

Seepage forces: Causes of failure of structures on permeable foundations, piping, rupture of floor, undermining, remedial measures, computation of uplift forces by Bligh's theory, Khoshla's theory, analytical method, and significance of exit gradient.

UNIT-III

*Canals:*Alignment, classification of alluvium canals and their functions, Regime concept of Kennedy's and Lacey's theories, design of canals based on Kennedy's and Lacey's method,
use of Garrett's diagrams for the design of canals, lining of canals, methods of lining and design of lined canals.

UNIT- IV

Canal falls: Definition, location, types of falls, design principles of trapezoidal notch fall, vertical drop fall, glacis fall.
Regulators and modules: Head regulator and cross regulators, canal escapes, canal outlets and modules-proportionality, sensibility and flexibility.

UNIT- V

Cross drainage works: Definition, classification, design principles of aqueducts, syphon aqueducts, canal syphons, super passages, inlets and outlets-selection of cross drainage works.

Suggested Reading:

1	B.C. Punmia and Pande B.B. Lal, Irrigation and Water Power Engineering, Standard Book House, 1991.
2.	S.K. Garg, Irrigation and Hydraulic Structures, Khanna Publishers, 1993.
3.	Modi P.N., Irrigation and Water Resources and Water PowerEngineering, Standard Book House, 1983.
4.	S. K. Sharma "Irrigation Engineering & Hydraulic Structures" S. ChandPublishers, New Delhi 2016
5.	Punmia, B.C., Pande B. and Lal, B, Ashok Kumar Jain & Arun Kumar Jain., 'Irrigation and Water Power Engineering', Laxmi Publishers, 2003

Professional Elective-III

PE 601CE	PAVEMENT CONSTRUCTION & MANAGEMENT					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1.	Provide common construction practices applicable for paving of subgrade, sub-base and bases courses,
2.	Understand construction details with equipment used for paving of different types of bituminous and concrete pavement layers
3.	Understand construction details of cement concrete pavements including applicable standards of joints.
4	Learn to provide various distresses of pavements based on the functional and structural characteristics.
5	Evaluate the condition of pavements through distress condition surveys, load/deflection, analysis of LCCA and apply the principles of pavement management systems.

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Develop construction procedures for subgrade, unbound, and bound granular layers with appropriate equipment.
CO-2	Understand construction of different layers of bituminous pavements including their standard specifications.
CO-3	Choose appropriate construction methods with details of cement concrete Pavements.
CO-4	Evaluate the performance of pavements based on the functional and structural characteristics.
CO-5	Able to develop basic skills and knowledge regarding principles of pavement management system and prepare life cycle cost analysis of pavements.

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2		2		1	1	1	1	1	
CO2	1		1	1	1		2		1		1		1	
CO3	3	3	2	2	3		2				1		1	
CO4	3	2	3	3	2	1					1		1	1
CO5	2	1	2	3	1								1	

UNIT- I:
Construction of Subgrade, Base, Subbase, Shoulders, Construction of Gravel Base, Cement Stabilized SubBases, WBM Bases, Wet Mix Construction (WMM); Overview on QC tests.

UNIT- II:

Bituminous Construction and Maintenance: Preparation and Laying of Tack Coat; Bituminous Macadam, Penetration Macadam, Built up Spray Grout, Open Graded Premix, Mix Seal, Semi-Dense Asphalt Concrete- IRC Specifications.

UNIT-III:

Cement Concrete pavement Construction and Maintenance: Cement Concrete Pavement Analysis – Construction of Cement Roads, Manual and Mechanical Methods, Joints in Concrete - IRC Specifications.

UNIT- IV:

Pavement Inventories and Evaluation: Serviceability Concepts; Visual Rating; Pavement Serviceability Index; Roughness Measurements ;Distress Modes – Cracking, Rutting Etc; Pavement Deflection – Falling Weight Deflectometer (FWD), Skid Resistance, Roughness in terms of International Roughness Index (IRI). Causes of Deterioration, Traffic and Environmental Factors, Approaches and Methods of Maintaining WBM, Bitumen and Cement Concrete Roads.

UNIT- V:

Pavement management system: Components of PMS and their activities; Major steps in implementing PMS; Inputs; Construction and Maintenance; Rehabilitation and Feedback systems; Life Cycle Cost Analysis (LCCA); Evaluating alternate strategies and Decision criteria ; Pavement Maintenance Management Components of Maintenance Management and Related Activities – Network and Project Level Analysis; Prioritization Techniques and Decision tree.

Suggested Reading:

1.	Srinivasa Kumar R, Pavement Evaluation and Maintenance Management System, Universities press, 2014.
2.	Haas and Hudson , W. R. Pavement management systems –McGraw Hill publications, 1987.
3.	Sargious, M. A. – Pavements and surfacing for highways and airports – Applied Science Publishers ltd, 1994
4.	Shahin M. Y, 1994- Pavement management for airports, roads and parking lots
5.	xIRC:SP:16, Guidelines on Measuring Road Roughness and Norsm, 2nd Revision, IRC, New Delhi, 2019.

PE 602 CE	PRESTRESSED CONCRETE					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student	
1.	Understand the basic concept of prestressed concrete and materials used.
2.	Learn the analysis prestress and load balancing concept.
3.	Study the flexural and shear design of prestressed concrete beam sections.
4	Know the concepts of deflections and end blocks of prestressed concrete sections

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Apply the concept of prestressing and determine the losses of prestress.
CO-2	Analyze the prestressed concrete beam and suggest the cable profile for beam.
CO-3	Design the prestressed concrete beam for flexure and shear.
CO-4	Analyze the prestressed continuous beam and determine concordant cable profile.
CO-5	Estimate the deflection of a prestressed concrete beam and design the end block

Articulation matrix of Course outcomes with PO's:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO 2**
CO1	3	3	3	-	-	-	-	3	-	-	-	-	3	3
CO2	3	3	3	-	-	-	-	3	-	-	-	-	3	3
CO3	3	3	3	-	-	-	-	3	-	-	-	-	3	3
CO4	3	3	3	-	-	-	-	3	-	-	-	-	3	3
CO5	3	3	3	-	-	-	-	3	-	-	-	-	3	3
Avg	3	3	3	-	-	-	-	3	-	-	-	-	3	3

Correlation rating: Low/ Medium/High:1/2/3respectively.

UNIT - I

Introduction to prestressed concrete: Concept of prestressing, historical development, definitions, advantages, applications, materials, prestressing systems.

Loss of prestress: Losses of prestress in pre-tensioned and post-tensioned members.

UNIT - II

Analysis of prestress: Basic assumptions, analysis of prestress, resultant stress, pressure line, kern points, cable profiles, load balancing concept, stress diagrams for prestress, dead load and live load.

UNIT - III

Simply supported continuous beams: Concordant cable profile, analysis of continuous prestressed concrete beams.

Design for flexure: Flexural strength design of rectangular, I and T sections using IS code provisions.

UNIT - IV

Design for shear: Shear and principal stresses, shear resistance of a PSC beam, design of shear reinforcement.

Design for torsion: Design of a PSC beam for torsion, shear and bending.

UNIT - V

Deflections: Importance of deflections, factors influencing deflections, codal provisions, short term and long term deflections. Deflections of simply supported beams with uniformly distributed and point loads.

Transmission length and Anchorage zone: Design of a transmission zone in pre-tensioned members and design of anchorage zone in post-tensioned members by IS method.

Suggested reading

1.	Prestressed Concrete, N Krishna Raju, Tata Mc Graw Hill Publishers, 6th Edition, 2018.
2.	Prestressed Concrete, N Rajagopalan, Narosa Publishers, 2nd Edition, 2010.
3.	Prestressed Concrete, P Dayaratnam and P Sarah, Medtech Publishers, 7th Edition, 2017.
4.	Prestressed Concrete, G S Pandit and S P Gupta, CBS Publishers, 2019.
5	Design of prestressed Concrete, S S Bavikatti, MEDTECH Scientific International Pvt. Ltd. Publishers, 2019.
6	Prestressed Concrete, K U Muthu et al., PHI Learning Pvt. Ltd. Publishers, 2016.

PE 603CE	GROUND IMPROVEMENT TECHNIQUES					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1.	To understand the objectives, necessity and scope of ground improvement techniques
2.	To learn different methods of in situ densification of cohesive, cohesionless soils
3.	To learn the classification, functions and applications of Geosynthetics in ground improvement
4	To learn the process of identification of necessity for ground improvement, finding alternative methods and recommendation of the ideal technique through case studies

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Ability to understand the necessity of ground improvement and evaluation of potential of a ground for improvement
CO-2	Comprehensive understanding about the improvement of in-situ cohesive soils as well as Cohesion less soils
CO-3	Knowledge of Grouting & other soil stabilization methods and competence to apply them for ground improvement
CO-4	Ability to understand and implement the Geosynthetic applications
CO-5	Competence to analyse an in-situ ground, identification of ground improvement techniques feasible, selection of the ideal method, its implementation and evaluation of improvement level

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2									2	2	2
CO2	2	2		3	2				3	3				
CO3	2	2		3	2	3								2
CO4	3			2	2	3			2	2	2		2	2
CO5	2	3			3	2	1	1			1	2	3	2
Avg	**2.4**	**1.8**	**0.4**	**1.6**	**1.8**	**1.6**	**0.2**	**0.2**	**1**	**1**	**0.6**	**0.8**	**1.4**	**1.6**

Correlation rating: Low/ Medium/High: 1/2/3 respectively

UNIT - I

Introduction : Objectives and necessity of Ground Improvement – Formation of Rock and soils – Alteration of ground after its formation – Reclaimed soils – Types and distribution of Soils in India - marine, black cotton soils (expansive), lateritic, alluvial, desert, peaty Soils etc - Ground improvement potential – Geotechnical processes.

UNIT - II

Surface Compaction methods: Compaction Mechanism - moisture density relationship – Factors affecting compaction – Laboratory evaluation of Compaction Characteristics – Field Surface Compaction Methods – Compaction procedure – Specification – Quality Control aspects.

In-situ Densification of Cohesionless Soils: Necessity for Deep compaction – Vibration methods – Vibro-compaction methods (Blasting, Vibratory probe, Dynamic compaction / heavy tamping), Vibro-displacement Methods (Displacement Piles, Sand Compaction Piles), vibro-replacement cum displacement methods (Vibro-floatation, Stone Columns).

UNIT - III

In-situ Densification of Cohesive Soils:

Drainage methods – Methods of dewatering systems - selection of pumps and accessories

Pre-compression methods – Concept & benefit of pre-compression -consolidation of Clayey soils – Pre-loading technique – consolidation acceleration methods - consolidation aided with vertical drains – Sand Drains - Pre-fabricated vertical drains, Consolidation by Electro- osmosis and vacuum compression methods - Compression monitoring.

UNIT - IV

Grouting: Aspects of grouting – Types of grout materials – Classification based on Groutability Ratio - grouting procedure – Applications of grouting in ground improvement.

Soil Stabilisation: Types and suitability of stabilization methods - Mechanical, Cementing methods – Aggregants and dispersants – Stabilization procedure – quality control in Soil Stabilization.

UNIT - V

Geo-Synthetics: Classification of Geosynthetics – Functions and applications – Concept of design by function.

Reinforced Soil Walls – Components of a RSW – Types of facia – Types of Reinforcement & factors influencing the selection - Design of RSW – construction procedure - Gabions.

Suggested Reading:

1.	H.R. Hausmann, (2013), *Principles of Ground Modification,* Mc-Graw Hill Publications.
2.	P.Nicholson, (2015), Soil Improvement and Ground Modification Methods, Butterworth-Heinemann Ltd.
3.	Purushotham Raj, (2016), *Ground Improvement Techniques,* Laxmi Publications.
4.	R.M.Koerner, (2012), *Designing with Geosynthetics Vol-1&2,* Prentice Hall Inc.
5.	Indrarathna, Chu, Cholachat, (2015), *Ground Improvement Case Histories*, Butterworth-Heinemann Publications

PE 604 CE	PRINCIPLES OF CLIMATE CHANGE					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student	
1.	Introduction to basic concepts of General Circulation Models and their importance
2.	Features of Indian summer monsoon rainfall (ISMR) and their characteristics
3.	Downscaling principles of statistical downscaling and dynamical downscaling

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Understanding of various components of Climate System, Vertical structure of Atmosphere and temperature.
CO-2	Comprehensive Understanding of water balance, distribution of precipitation
CO-3	Ability to comprehend the monsoon wind patterns, ISMR characteristics, floods and droughts.
CO-4	Analysis and synthesis on the causes of climate change on hydrology using General Circulation Models (GCMs)
CO-5	Modeling of climate variables using various downscaling approaches and Applications of Hydrologic models

Articulation matrix of Course outcomes with PO's:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO 2**
CO1	2	2	2	2	2	2	2		2	2		1	3	2
CO2	2	2	2	1	3		1		1			1	3	3
CO3	3	2	3	2	3	1	1		1	1		1	3	1
CO4	1	2	1	2	2	1	1		1	1		1	3	2
CO5	3	3	-	2	2	1	1		1	1		1	2	2
Avg														

Correlation rating: Low/ Medium/High:1/2/3respectively.

UNIT–I

Climate System- Weather and Climate- Overview of earth system- Atmosphere- Biosphere- Lithosphere- General Circulation of the atmosphere- Modeling of hydrological Systems- vertical structure of atmosphere- Solar Radiation and Temperature- Temperature variation- vertical variation in Air temperature- temperature extremes.

UNIT–II

Introduction- Global water balance- cycling of water on land- simple water balance- climate variables affecting precipitation- forms and types of precipitation. Climate Classification - Storms and Hurricanes- Global Ocean Circulation – El Nino and its Effect -

UNIT – III

Monsoon- wind patterns - Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies - Cloud Formation and Monsoon Rains –clouds- Types of clouds-Indian summer monsoon Rainfall (ISMR) - characteristics- climate variability- Floods- droughts- drought Indicators - climate extremes.

UNIT – IV

Causes of climate change - Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large Scale Variability – Drivers of Climate Change – Changes in Extreme Events – UNFCCC – IPCC -Modeling of climate change-General circulation models (GCMs) –IPCC scenarios - IPCC Assessment Report (AR5) - Physical Science basis.

UNIT–V

CMIP Data Downloading- Bias correction methods -Downscaling – Types of downscaling- Dynamical downscaling-Regional Climate Models - statistical downscaling - Types of statistical downscaling - climate predictors - data reduction techniques -principal component analysis- step wise regression- Lasso- - Kernel Regression - SDSM software - Hydrology models - Introduction on Soil and water assessment tool SWAT and VIC (variable Infiltration capacity models).

Suggested Reading:

1.	Bonon G B - Ecological climatology- Cambridge University Press Edition- II - ISBN-1107268869, 2008
2.	Physical science basis of AR 5 report of IPCC - working group I contribution to Assessment Report- https://ipcc.ch/report/ar5/wg1/ 2013.
3.	Soil and Water Assessment Tool SWAT- user Manual Report (2005) http://swat.tamu.edu/media/1294/swatuserman.pdf 2005
4.	Richardson. B.A., (1980), Remedial Treatment of Buildings, Construction Press, London
5.	VIC model Macro scale Hydrologic Model- http://www.hydro.washington.edu/Lettenmaier/Models/VIC/index.shtml
6.	Rasmus E Benestad, Inger Hanson Baver, Delinag Chen (2008) Empirical Downscaling World Scientific Publishing Co. Ltd. 2008.
7.	K Srinivasa Raju and Nagesh Kumar (2018) Impact of climate change on water resources , Springer publications
8.	Karamouz, M , S Nazif, M.Falahi Hydrology and Hydroclimatology Principles and Applications 2012 , CRC Press.

PE 605CE	RAILWAY INFRASTRUCTURE PLANNING & DESIGN					
Pre-requisites		**L**	**T**	**P**	**C**	
		3	-	-	3	
Evaluation	**SEE**	60 Marks	**CIE**	40 Marks		

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1.	To understand basics related to alignment of Railway lines
2.	To know the various track components
3.	To know the elements of geometric design of track
4	To know the functions and requirements of various elements of Permanent way
5	To understand the various methods of signaling interlocking methods

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Understand general features and alignment of railway lines
CO-2	Understand the concepts related to rails, sleepers, track and track stresses
CO-3	Able to design the geometrics of railway track
CO-4	Understand the concepts related to sub grade, formation and ballast
CO-5	Understand the concepts related to points and crossings with modern signaling system

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	3	2	1	2		1	1	2		2	2
CO2	2	2	2	2	2								1	1
CO3	3	3	3	2	3	2	2		1	1		1	3	2
CO4	2	2		2	2						1		2	
CO5	2	1	1	2	3	1	1		1	1	2	1	2	2

Correlation rating: Low/ Medium/High: 1/2/3 respectively

UNIT-I

General Features and Alignment of Railway Lines: Development in Indian railways, Organization of Indian Railways, Classification of railway lines, General features of Indian railways, important statistics. Alignment of railway lines: Good Alignment, basic requirements of an Ideal alignment, selection of good alignment, Railway track Gauge: Gauges on World and Indian Railways, Engineering surveys and construction of new lines.

UNIT-II

Rails, Sleepers, Track and Track Stresses: Requirements of good track, Maintenance of permanent way, Coning of wheels, Tilting of rails. Rails: functions and types, requirements for an ideal rail section, rail manufacture, rail wear, defects in rails and rail flaw detection. Creep: causes, effects of creep, measurement of creep, adjustment of creep. Sleepers: functions and requirements, sleeper density and spacing of sleepers, types of sleepers.

UNIT-III

Geometric Design of Track; Necessity of Geometric design, details of geometric design of track, Gradients and grade compensation on curves, Super elevation, transition curve, reverse curve, extra clearance of curves, widening of gauge on curves, vertical curves, cutting rails on curves, check rails on curves.

UNIT-IV

Sub grade Formation and Ballast; Slopes of formation, execution of earthwork in embankments and cuttings, Blanket and blanketing Material, Failure of railway embankment, site investigations. Ballast: functions, types, sizes of ballast, requirement of good ballast, design of ballast section, collection and transportation of ballast, methods of measurement, laboratory tests for physical properties of ballast. Guidelines for provision of sub ballast, Track Drainage.

UNIT – V

Points and Crossings, Signaling and Interlocking: Important terms, Switches, Design of Tongue rails, Turnouts: layout of turnout, trends in turnout design on Indian Railways, inspection and maintenance of points and crossings. Level crossing: Classification, dimensions, Accidents at level crossing and remedial measures, maintenance and inspection. Signaling and interlocking: Objectives, classification, signaling systems, systems for controlling train movement, interlocking, modern signaling installations.

Suggested Reading:

1.	Chandra, S.and Agarwal.M.M. "Railway Engineering". Oxford University Press, New Delhi, 2013.
2.	Rangwala, K. S. "Principles of Railway Engineering".Charotar publishing House, India, 2015
3.	Mundrey J.S. "Railway Track Engineering". McGraw Hill Education (India) Private Limited,2009
4.	Clifford F. Bonnett.. "Practical Railway Engineering" (2nd Edition), Imperial College Press,2005.
5.	GOVERNMENT OF INDIA, MINISTRY OF RAILWAYS (RAILWAY BOARD). Indian *Railways Code for the Engineering Department. (Revised Edition- 1982) (Fourth Re-print*)

PE 606 CE	FINITE ELEMENT METHODS					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1.	Learn concepts of finite element method and potential-energy approach.
2.	Study 1-D analysis using 2-node axial bar element with application problems.
3.	Learn 2-D analysis using 3-node triangular element and 4-node quadrilateral with application problems.
4	Study 3-D analysis using 3-node triangular ring element, 4-node Tetrahedron element and 8-node hexahedron element with application problems.
	Apply FEM concepts to Civil Engineering problems such as 2-D plane trusses, beams and 2-D plane frames using appropriate elements.

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Answer problems of finite element method and potential-energy approach.
CO-2	Solve 1-D problems using 2-node axial bar element.
CO-3	Work out 2-D problems using 3-node triangular element and 4-node quadrilateral
CO-4	Answer 3-D problems using 3-node triangular ring element, 4-node Tetrahedron element and 8-node hexahedron element
CO-5	Solve Civil Engineering problems such as 2-D plane trusses, beams and 2-D plane frames.

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3		3		3	3	3	2	3	3	3
CO2	3	3	3	3		3		3	3	3	2	3	3	3
CO3	3	3	3	3		3		3	3	3	2	3	3	3
CO4	3	3	3	3		3		3	3	3	2	3	3	3
CO5	3	3	3	3		3		3	3	3	2	3	3	3

Correlation rating: Low/ Medium/High: 1/2/3 respectively

UNIT - I

Introduction to FEM: Types of problems – Types of materials – Elastic / inelastic situations – Types of forces - Body forces / Surface Traction / Point loads – Types of deformations – Homogeneous / Non homogeneous problems – Equations of equilibrium for elastic 2-D / 3-D continua - Equilibrium equations for 2-D / 3-D boundary elements – Boundary conditions – Strain-displacement relation - Stress-strain relation for 2-D / 3-D problems – Plane stress / Plane strain problems – Initial strain -

Displacement model - Criterion for convergence - Conforming and non-conforming elements – Subparametric / Superparametric / Isoparametric formulations.

Potential-Energy / Variational Approach: Rayliegh-Ritz Method – Galerkin's Method – Application to discrete connected system and 1-D axial bar.

UNIT - II

1-D Bar Elements: 1-D 2-node axial bar element - Finite element modeling – Natural coordinates - Shape functions – Strain-displacement relation matrix - Potential-energy approach - Stiffness matrix – Body force
vector – Traction force vector – Assembly of global stiffness matrix and load vector – Finite element equations – Treatment of boundary conditions – Elimination approach – Penalty approach – Multipoint constraints – Temperature effects – Application problems.

UNIT III

2-D Triangular Elements: 2-D 3-node triangular element - CST - Shape functions – Area coordinates - Isoparametric formulations - Strain-displacement matrix – Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector - Temperature effects – Application problems.

2-D Isoparametric Quadrilateral Elements: 2-D 4-node quadrilateral - Shape functions – Jacobian matrix - Strain-displacement matrix - Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector – Numerical integration - Gaussian quadrature – 1-D and 2-D integrals - Application problems.

UNIT - IV

3-D Axisymmetric Problems: Axisymmetric formulation - Finite element modeling - 3-node triangular ring element - Strain-displacement matrix - Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector - Temperature effects – Application problems.

3-D Tetrahedron / Hexahedron Elements: Finite element formulation – 3-D 4-node Tetrahedron element - 3-D 8-node hexahedron / brick element - Shape functions – Volume coordinates - Jacobian matrix - Strain-displacement matrix - Potential-energy approach - Stiffness matrix – Body force vector – Traction force vector – Application problems.

UNIT - V

Civil Engineering Problems:

2-D Trusses: 2-D Plane Truss – Local and global coordinate systems – Transformation matrix – Potential-Energy approach - Stiffness matrix – Strain-displacement matrix - Stress – Temperature effects – Application problems.

Beams: Finite element formulation - Hermite shape functions – Potential-energy approach - Stiffness matrix – Load vector – Shear force – Bending moment – Reaction – Application problems.

2-D Plane Frames: 2-D Plane frame element – Local-global transformation matrix – Potential-energy approach - Stiffness matrix – Load vector – Application problems.

Suggested Reading:

1.	Cook, R. D. (1981). "Concepts and Application of Finite Element Analysis", John Wiley and Sons.
2.	Zienkiewicz, O. C. And Taylor, R. L, (1989). "The Finite Element Method", Vol.1, McGraw Hill Company Limited, London.
3.	Reddy, J. N, (1993). "An Introduction to the Finite Element Method", McGraw Hill, New York.
4.	Chandrupatla, T. R. And Belegundu, A. D, (2001). "Introduction to Finite Elements in Engineering", Prentice Hall of India, New Delhi
5.	Seshu. P, (2003). "Finite Element Analysis", Prentice Hall of India Private Limited, New Delhi
6.	David V. Hutton, (2005). "Fundamentals of Finite Element Analysis", Tata McGraw- Hill Publishing Company Limited, New Delhi.
7	Bathe, K. J, (2006). ―Finite Element Procedures‖, Prentice Hall of India, New Delhi.

PE 604 CS	DEEP LEARNING					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1.	To understand complexity of Deep Learning algorithms and their limitations
2.	To understand complexity of Deep Learning algorithms and their limitations
3.	To apply Deep Learning algorithms in practical applications
4	To perform experiments in Deep Learning using real-world data

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Understand the concepts of Neural Networks, its main functions, operations and the execution pipeline
CO-2	Implement deep learning algorithms, understand neural networks and traverse the layers of data abstraction..
CO-3	Learn topics such as Convolutional neural networks, recurrent neural networks, training deep networks and modifications
CO-4	Build deep learning models in PyTorch and interpret the results

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

Correlation rating: Low/ Medium/High: 1/2/3 respectively

UNIT-I

Artificial Neural Networks: Introduction, Perceptron, XOR Gate ,Perceptron Training Rule, Activation Functions.

Linear Neural Networks: Linear Regression, Implementation of Linear Regression, Softmax Regression, The Image Classification Dataset , Implementation of Softmax Regression

UNIT-II

Multilayer Perceptrons:

Multilayer Perceptrons, Implementation of Multilayer Perceptrons, Model Selection, Underfitting and Overfitting, Weight Decay, Dropout, Forward Propagation, Backward Propagation, and Computational Graphs, Numerical Stability and Initialization, Considering the Environment, Predicting House Prices on Kaggle.

Optimization Algorithms: Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descent, Mini batch Stochastic Gradient Descent, Momentum, Adagrad, RMS Prop, Ada delta, Adam, Learning Rate Scheduling.

UNIT-III

Introduction to Convolutional Neural Networks

Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple Filters, **Modern Convolutional Neural Networks**

Deep Convolutional Neural Networks (AlexNet), Networks Using Blocks (VGG), Network in Network (NiN), Networks with Parallel Concatenations (GoogLeNet), Batch Normalization, Residual Networks (ResNet), Densely Connected Networks (DenseNet).

UNIT-IV

Recurrent Neural Networks: Sequence Models, Text Preprocessing, Language Models and the Dataset, Recurrent Neural Networks, Implementation of Recurrent Neural Networks from Scratch, Concise Implementation of Recurrent Neural Networks, Back propagation Through Time**.**

Modern Recurrent Neural Networks: Gated Recurrent Units (GRU), Long Short Term Memory (LST), Deep Recurrent Neural Networks, Bidirectional Recurrent Neural Networks, Machine Translation and the Dataset-Encoder-Decoder Architecture, Sequence to Sequence, Beam Search.

UNIT-V

Auto Encoders : Types of Auto Encoders and its applications- **Generative Adversarial Networks:** Generative Adversarial Network, Deep Convolutional Generative Adversarial Networks

Suggested Readings:

1 Goodfellow, I., Bengio,Y., and Courville, A., "*Deep Learning"*, MIT Press, 2016.

2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "*Dive into Deep Learning",* 2020.

LIST OF OPEN ELECTIVES I (BE VI Semester)

1) OE 601 BM Engineering Applications in Medicine
2) OE 602 BM Human Assistive Technologies
2) OE601 CE Disaster Management
4) OE 602 CE Road Safety Engineering
5) OE 601 EC Verilog HDL
4) OE 602 EC Principles of Electronic Communication Systems
5) OE 601 ME 3D Printing Technology
6) OE 602 ME Finite Element Method
7) OE 601 EE Applications of Electrical Energy
8) OE 602 EE Electrical Safety Management
9) OE 601 CS Python Programming
10) OE 602 CS Cyber security

OE 601 BM	**ENGINEERING APPLICATIONS IN MEDICINE**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	To make the students gain basic knowledge of Human Physiology.
2.	To make the students learn the applications of various branches of engineering in Medicine.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Describe the major organ systems of the human body
CO-2	Understand the concepts of bioelectricity and medical instruments
CO-3	Apply solid and fluid mechanics principles to joints and blood flow respectively
CO-4	Learn the need and applications of BCI.
CO-5	Analyze and choose proper biomaterial for various applications

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1														
CO2														
CO3														
CO4														
CO5														

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT-I

Evolution of Modern healthcare, Major organ systems- Cardiovascular, Respiratory, Nervous,

Skeletal, Muscular. Homeostasis. Physiological signals and their diagnostic importance.

UNIT-II

Bioelectricity-Excitable cells, Resting potential, Action potential, Accommodation, Strength-Duration Curve, Propagation of impulses in myelinated and unmyelinated nerves. Medical Instrumentation System-Functions, Characteristics, Design Challenges. Signal Processing-QRS detection.

UNIT-III

Solid mechanics-Analysis of muscle force and joint reaction force for the limb joints. Fluid mechanics-Factors governing and opposing blood flow, Wind-Kessel model, Application of Hagen-Poiseuille flow to blood flow.

UNIT-IV

Brain-Computer Interface: Brain signals for BCIs, Generic setup for a BCI, Feature extraction and Feature translation involved in BCIs. Typical applications-Word forming, Device control.

UNIT-V

Materials and Tissue Replacements-Types of Biomaterials- Metals, Polymers, Ceramics and Composites and their applications in Soft and Hard tissue replacements. Implants- Manufacturing process, Design, fixation.

Suggested Reading:

1.	John Enderle, Susan M. Blanchard and Joseph Bronzino, *Introduction to BiomedicalEngineering*, Second Edition, Elsevier, 2005.
2.	Ozkaya, Nordin. M, *Fundamentals of Biomechanics*, Springer International Publishing,4th Edition, 2017.
3.	Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
4.	John G.Webster, *Medical Instrumentation: Application and Design*, John Wiley and SonsInc., 3rd Ed., 2003.

OE 602 BM	**HUMAN ASSISTIVE TECHNOLOGIES**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	To extend knowledge of the amputee, of lost and remaining functions affecting locomotion, and to collect information on the best possible medical treatment.
2.	To improve fitting techniques and practices, including training, so that existing devices might be used with greater comfort and function.
3	To develop improved lower-extremity devices.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Apply fundamental knowledge of engineering in rehabilitation
CO-2	Apply analytical skills to assess and evaluate the need of the end-user
CO-3	Develop self-learning initiatives and integrate learned knowledge for problem solving
CO-4	Understand the basics of robotics and apply their principles in developing prosthetics
CO-5	Apply the knowledge of computers in solving rehabilitation problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1														
CO2														
CO3														
CO4														
CO5														

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT- I

Introduction to Rehabilitation Engineering, Definition of Rehabilitation Engineering, Scope and importance of the field, Historical perspective. Interdisciplinary nature and collaboration with healthcare professionals. Physical disabilities: mobility impairments, spinal cord injuries. Cognitive disabilities: learning disabilities, traumatic brain injuries. Psychosocial aspects of disability.

UNIT-II

Assistive Technology, Human Factors and Ergonomics in Assistive Technology Design. Mobility Aids, Types of Wheelchairs and design aspects: Manual wheelchairs, Powered wheelchairs, Customizable features and design considerations, Auxiliary devices and systems. Human-Centered Designing.

UNIT – III

Sensory disabilities: visual and hearing impairments. Sensory augmentation and substitution: Visual system: Visual augmentation. Tactual vision substitution, Auditory vision substitution; Auditory system: Auditory augmentation. Cochlear implantation, Visual auditory substitution, Tactual auditory substitution, Tactual system: Tactual augmentation. Tactual substitution. Assessment and Outcome Measurement

UNIT–IV

Rehabilitation Robotics, Exoskeletons, Major Limb Prosthetic Devices, Orthotic Devices, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Controlled orthotics and prosthetics Materials and fabrication techniques, Functional and cosmetic considerations. FES system, Restoration of Hand function, Restoration of standing and walking, Myo-electric Hand.

UNIT-V

Case Studies and Real-World Applications. Augmentative and Alternative communications, Software tools for simulation and testing. Virtual reality applications in rehabilitation. Machine learning applications in assistive technology. Predictive analytics for personalized rehabilitation

Suggested Reading:

1.	Robinson C.J., *Rehabilitation Engineering*, CRC Press, 1995.
2.	Ballabio E., et al., *Rehabilitation Technology*, IOS Press, 1993.
3.	Rory A Cooper, Hisaichi Ohnabe, Douglas A. Hobson, *Series in medical physis and biomedical engineering: An introduction to rehabilitation engineering*, Taylor and Francis Group, London, 2007.
4.	Joseph D. Bronzino *The biomedical engineering handbook -biomedical engineering fundamentals*, 3rd Ed., CRC Press, Taylor & Francis Group, London, 2006.

OE 601CE	**DISASTER MANAGEMENT**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	To introduce basic conceptual understanding of natural & man-made hazards and different contextual aspects.
2.	To develop the knowledge and understanding of the International and national strategy for disaster reduction (UN-ISDR)
3.	To ensure skills and abilities to analyze potential effects of disasters and of the strategies and methods to deliver public health response to avert these effects.
4.	To promote the use of science and technology for implementing the disaster risk reduction (DRR) plans and policies.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Aptitude to link hazards, risk, vulnerability, differential impacts and capacity building to the life and property loss during disasters and its impacts on the society and sustainability.
CO-2	Ability to understand various aspects of natural and man-made hazards and emerging trends
CO-3	Acquaintance with different steps involved in disaster risk reduction (DRR) and international initiatives for prevention, mitigation and preparedness.
CO-4	Knack to appreciate the National Policy and Role of individuals, communities, and government organizations in disaster management.
CO-5	Capacity to identifying current technological constraints and hazard specific solutions, particularly construction codes etc.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1														
CO2														
CO3														
CO4														
CO5														

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT I: INTRODUCTION TO DISASTER

Understanding the Concepts, Definitions and Terminologies used in the field of Disaster Management (i.e. Hazard, Risk, Vulnerability, Resilience, and Capacity Building); Differential impacts of Disasters in terms of Gender, Age, Social Status, Location, Prosperity, Disabilities; Disaster- Development Nexus.

UNIT II: TYPES of HAZARDS AND EMRGING TRENDS

Classification, Causes, Consequences and Controls of: Geophysical hazards-Earthquakes, Landslides, Tsunami; Weather related hazards- Meteorological (Cyclones, and Storm- surge), Hydrological (Floods, Droughts, Avalanches), Climatological (Wildfire, Cold & Heat Waves); Biological hazards-Epidemic & Pandemics; Technological hazards- Chemical, Industrial, Nuclear; Man-made hazards-Structural Failure, Fire, Transportation accidents, Terrorism and Wars; Emerging Disasters- Urban Areas, Climate Change; Regional and Global Trends-loss of life & Property in various hazards

UNIT-III: DISASTER MANAGEMENT CYCLE AND INTERNATIONAL FRAMEWORK

Disaster Management Cycle: Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro-zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Building; Awareness; During Disaster –

Evacuation – Disaster Communication – Search and Rescue– Emergency Operation Centre – Incident Command System – Relief and Rehabilitation; Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery– Reconstruction and Redevelopment; Paradigm Shift in Disaster Management: International Decade for Natural Disaster Reduction; Yokohama Strategy; Hyogo Framework of Action

UNIT IV: DISASTER RISK MANAGEMENT IN INDIA

Disaster Profile of India – Mega Disasters of India and Lessons Learnt; Disaster Management Act 2005 – Institutional and Financial Mechanism; National Policy on Disaster Management; National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-governmental Agencies

UNIT V: TECHNOLOGICAL APPROACHES TO DISASTER RISK REDUCTION

Geo-informatics in Disaster Management (RS, GIS, GPS and RS); Technological in Disaster Communication System (Early Warning and Its Dissemination), rescue and restoration of services; Disaster Safe Designs and Constructions; Application of technology and innovations for Structural and Non Structural Mitigation; Science & Technology Institutions for Disaster Management in India

Suggested Reading:

1.	Coppola D P, 2007. Introduction to International Disaster Management, ElsevierScience (B/H), London.
2.	Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi

3.	An overview on natural & man-made disasters and their reduction, R K Bhandani,CSIR, New Delhi
4.	World Disasters Report, 2009. International Federation of Red Cross and Red Crescent, Switzerland
5.	Disasters in India Studies of grim reality, Anu Kapur& others, 2005, 283 pages,Rawat Publishers, Jaipur
6	National Disaster Management Policy, 2009, GoI.
7	Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management

OE 602CE	ROAD SAFETY ENGINEERING					
Pre-requisites	Mathematics		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60Marks	**CIE**		40Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To introduce the fundamentals of road safety and road safety audit
2	To get familiarized with various road safety techniques, measures and their applications
3	To be able to understand and evaluate various traffic control devices
4	Familiarize with traffic management techniques
5	To examine and analyze the incident management process

Course Outcomes :	
On completion of this course, the student will be able to:	
CO-1	Analyze Accident data
CO-2	Plan and design of road safety improvement programs
CO-3	Apply the principles of road safety in urban transport
CO-4	Apply traffic management techniques
CO-5	Able to plan effective incident management program

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	2	2	2			2				2	2
CO2	2	2	2	2	2	2		2		1	1		1	1
CO3	2	2	1	1	1	1						1	2	
CO4	3	2	2	2	2	2		1	2			2	3	2
CO5	1	3	3	3	2	3	2	1	2	1	2	1	1	2

Correlation rating: Low/ Medium/High:1/2/3 respectively

UNIT-I

Road accidents: Causes, scientific investigations and data collection, analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of road accident statistics, safety performance function: The empirical Bayes method identification of hazards road location. Application of computer analysis of accident data.

UNIT-II

Safety in Road Design: Operating the road network for safety, highway operation and counter measures, road safety audit, principles-procedures and practice, code of good practice and checklists, vehicle design factors & driver characteristics influencing road safety

UNIT-III

Road Signs and Traffic Signals: Classification, Location of signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility, sign variables, Text versus symbols, Road marking: Role of road marking, classification, visibility. Traffic signals: Need, Signal face illumination and location of signals, factors affecting signal design, pedestrian's safety, fixed and vehicle actuated signals. Design of signals, area traffic control, Delineators, traffic impact attenuators, road side rest areas, safety barriers, traffic aid posts

UNIT IV

Traffic Management Techniques: Integrated safety improvement and traffic calming schemes, speed and load limit, traffic lights, safety cameras, tests on driver and vehicles, pedestrian safety issues, parking, parking enforcement and its influence on accidents, travel demand management, methods of traffic management measures: restriction of turning movements, One way streets, tidal flow operation methods, exclusive bus lanes and closing side-streets; latest tools and techniques used for road safety; legislation, enforcement, education and propaganda.

UNIT-V

Incident Management: Introduction, characteristics of traffic incidents types of incidents, impacts, incident management process, incident traffic management; application of ITS: Motorist information, equipment used; planning effective incident management program, best practice in incident management programs. National importance of survival of transpiration systems during and after all natural disasters especially cyclones, earthquakes, floods etc and manmade disasters like sabotage, terrorism etc.

Suggested Reading:

1.	Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017
2.	KadiyaliL.R,.*Traffic Engineering and Transport planning*, 9th Edition, Khanna Tech Publishers, 2013.
3.	Donald Drew, *Traffic Flow Theory Chapter 14 in Differential Equation Models*, Springer, 1983
4.	C. Jotinkhisty and B. Kent Lall, *Transportation Engineering – An Introduction, 3rd Edition, Pearson publications, 2017*
5.	Rune Elvik, Alena Hoye, TrulsVaa, Michael Sorenson, *Handbook of Road Safety measures, second Edition, Emerald Publishing, 2009.*

Course Code	Course Title					Course Type
OE 601 CS	PYTHON PROGRAMMING					OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To know the basics of Programming
- To convert an algorithm into a Python program
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions
- To use Python data structures-lists, tuples, dictionaries.
- To do input/output with files in Python.
- To construct Python programs as a set of objects.

Course Outcomes:

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Develop simple Python programs for solving problems.
4. Structure a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries.
6. Read and write data from/to files in Python Programs

UNIT-I

Introduction to Computing and Problem Solving: Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms.

Introduction to Python Programming: Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements, Reading Input, Print Output, Type Conversions, The type() Function and Is Operator, Dynamic and Strongly Typed Language.

Control Flow Statements: The if, The if…else,The if…elif…else Decision Control Statements, Nested if Statement, The while Loop, The for Loop, The continue and break Statements.

UNIT-II

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, Command Line Arguments.

Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

UNIT-III

Files and Exception: Text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings

Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.

UNIT-IV

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance The Polymorphism.

Functional Programming: Lambda. Iterators, Generators, List Comprehensions.

UNIT-V

GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

Suggested Readings:

1. Richard L. Halterman, "*Learning To Program With Python*", Copyright © 2011.
2. Dr. Charles R, "*Python for Everybody, Exploring Data Using Python 3*", Severance. 2016.
3. Gowrishankar S., Veena A, "*Introduction to Python Programming*", CRC Press, Taylor & Francis Group, 2019.
4. Allen B. Downey, "*Think Python: How to Think Like a Computer Scientist*", 2nd Edition, Shroff O"Reilly Publishers, 2016

Course Code	Course Title					Course Type
OE 602 CS	CYBER SECURITY					OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- Learn the various threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and IT laws and policies.

Course Outcomes:

1. Understand the various network threats
2. Analyze the forensic tools for evidence collection
3. Apply the firewalls for threat analysis

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, search and seizure of computer systems, password cracking.

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrieval, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act

Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings:

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.

2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.

3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.

4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.

5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

OE 601 EC	**VERILOG HDL**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	To familiarize with various modeling styles: structural, dataflow and behavioral of Verilog HDL
2.	To develop combinational and sequential circuits using various modeling styles of Verilog HDL
3	To design and develop Verilog HDL models of data path and control units of Central Processing Unit (CPU)
4	To learn Synthesis and FPGA design flow.
5	To design and develop real time applications: Booth's multiplier, Divider, hardwired control for basic CPU, FIR filter.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Implement and distinguish different Verilog HDL modeling styles
CO-2	Construct and analyze Verilog HDL models of combinational and sequential circuits
CO-3	Design and develop Verilog HDL modeling and test bench for digital systems for the given specifications
CO-4	Outline FPGA design flow and timing analysis
CO-5	Understand implementation of real time applications

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	1	2	2	-	-	-	-	-	2	-	-	-	2	-
CO2	2	2	2	-	2	-	-	-	2	2	-	-	2	-
CO3	2	3	3	-	2	-	-	-	2	2	-	-	2	--
CO4	2	3	3	-	2	1	-	-	2	2	-	2	2	-
CO5	2	2	2	-	-	1	-	-	2	1	-	2	2	-

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT - I

Introduction to HDL: Overview and Importance of HDLs, Differences between HLL, HDL and ALP. Design methodologies, Modules, Lexical Conventions, Number Specifications, Strings, Identifiers and Keywords Data types, System task and compiler Directives, Port declaration and port connection rules

UNIT-II

Structural and Dataflow modeling: gate-level modeling, delays, hazards, dataflow modeling: Continuous Assignments, Delays, Expressions, Operators and Operands, Operator Types and Design Examples.

UNIT – III

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules Simulation: Types of Simulation, Event driven Simulation and Cycle Based Simulation; design examples.

UNIT–IV

Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions, Tasks and Functions. Verilog HDL synthesis, synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples.

UNIT-V

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units

Suggested Reading:

1.	Samir Palnitkar, *"Verilog HDL A Guide to Digital Design and Synthesis,"* 2nd Edition, Pearson Education, 2006.
2.	Ming-Bo Lin, ―*Digital System Designs and Practices: Using Verilog HDL and FPGA,"* Wiley India Edition, 2008.
3.	J. Bhasker, *"A Verilog HDL Primer*,‖ 2nd Edition, BS Publications, 2001.
4.	

OE 602 EC	**PRINCIPLES OF ELECTRONIC COMMUNICATION SYSTEMS**					
Pre-requisites		**L**	**T**	**P**	**C**	
		3	-	-	3	
Evaluation	**SEE**	60 Marks	**CIE**	40 Marks		

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	Provide an introduction to fundamental concepts in the understanding of Electronic communications systems
2.	Provide an introduction to network model and some of the network layers including physical layer, data link layer, network layer and transport layer.
3.	Provide an introduction to the evolution of wireless systems and current wireless technologies.
4	Provide an introduction to fundamental concepts in the understanding of Telecommunication and optical communications systems
5	Provide an introduction to fundamental concepts in Analog and Digital Communications

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the working of analog and digital communication systems
CO-2	Understand the OSI network model and the working of data transmission
CO-3	Understand the concepts of modulation and demodulations
CO-4	Understand the evolution of communication technologies from traditional telephony systems to modern wireless communication systems.
CO-5	Understand the principles of optical communications systems

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	2	2	2	1	1	-	-	-	1	1	1	1	2	2
CO2	2	1	2	1	-	-	-	-	1	1	1	1	2	1
CO3	2	1	1	1	-	-	-	-	1	1	1	1	2	1
CO4	2	2	2	2	-	1	1	1	1	1	1	1	2	2
CO5	2	1	2	2	1	-	1	-	1	1	1	1	2	1

Correlation rating: **Low / Medium / High: 1 / 2 / 3 respectively.**

UNIT- I

Introduction to communication systems: Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels, Signal Transmission Concepts-Baseband transmission and Broadband transmission, Communication parameters-Transmitted power, Channel bandwidth and Noise, Need for modulation Signal Radiation and Propagation-Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation.

UNIT- II

Analog and Digital Communications: Amplitude modulation and demodulation, FM modulation and demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation.

UNIT- III

Data Communication and Networking: Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet, Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP.

UNIT- IV

Telecommunication Systems: Telephones, Telephone system, Paging systems, Internet Telephony. Optical Communications: Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.

UNIT- V

Wireless Communications: Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, And OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks.

Suggested Reading:

1.	Louis E. Frenzel, "*Principles of Electronic Communication Systems*", 3e, McGrawHill publications, 2008.
2.	Behrouz A. Forouzan, *"Data Communications and Networking",* 5e TMH, 2012.
3.	Kennady, Davis, "*Electronic Communications systems*", 4e, TMH, 1999.
4	Keiser Gerd "Optical Fiber Communication (SIE)",5th Edition, McGraw Hill Education India,2017.
5	Simon Haykin, "Communication Systems", 5th Edition, Wiley publications, 2006.

OE 601 EC	**APPLICATIONS OF ELECTRICAL ENERGY**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	To introduce the students and understand Utilization of electrical energy for various applications like industrial heating.
2.	To understand various techniques of electric welding and types of batteries.
3	To understand the concept of illumination and study about the laws of illumination.
4	To know the applications of various lamps to factory lighting, street lighting etc.
5	To understand the concept of electric traction including speed – time curves of different traction services.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify a suitable heating scheme for a given application
CO-2	Identify proper welding technique and various characteristics of batteries
CO-3	Study the nature and production of light and laws related to illumination.
CO-4	Classify types of electric light sources based on nature and operation and their objectives, performance and reliability
CO-5	Determine the speed-time characteristics of various traction services and also estimate the energy consumption levels at various modes of operation.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO2	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO3	3	2	2	-	-	2	-	-	1	-	-	1	2	1
CO4	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO5	3	1	2	-	-	2	-	-	1	-	-	1	2	1

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens, Design of heating element. High frequency heating, Induction Heating, Induction furnaces, Core type, Coreless furnaces, Dielectric heating.

Electric Arc furnaces, Direct Arc furnace, Indirect Arc furnaces.

UNIT II

Electric welding: Classification of electric welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

UNIT III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, Lighting calculations, Determination of M.S.C.P, Rousseau‟s construction.

UNIT IV

Types of lamps - Discharge lamps, Sodium vapour lamps, Mercury vapour lamps, Fluorescent lamp. Starting and power factor corrections, stroboscopic effects, Neon signs, Application to factory lighting, Street lighting and Flood lighting.

UNIT V

Electric Traction: System of Electric Traction, Transmission of drive, Systems of track electrification, Traction mechanics, Speed time curves, Tractive effort, Power of Traction motor, Specific energy consumption, Mechanics of train movement, Coefficient of adhesion.

Suggested Reading:

1	Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2.	K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimating 1. and Costing, Wiley Eastern Ltd., 1991.
3.	Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
4.	B.L.Theraja, A Text Book of Electrical Technology, S.Chand & Company Ltd, Vol-I.

Course Code	Course title						Core/PE/OE
OE 602 EE	ELECTRICAL SAFETY MANAGEMENT						OE
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives

1.

1. Understand electrical safety measures, the hazards associated with electric current, and voltage identify different types of electrical shocks
2. Understand installation work of electrical plant and equipment. Safety during installation of outdoor switchyard equipment, safety during installation of electrical rotating machines.
3. Understand procedure of domestic wirings ,to handle different domestic electrical appliances, Procedure of Agricultural pump installation
4. Identifies different hazardous zones, classification of equipment enclosure for various hazardous gases, importance of earthing system. Understand Management Safety Policy
5. Understand standards on electrical safety, different IE Rules and Acts

Course Outcomes

After the completion of this course, the students shall be able to:

1. Explain the objectives and precautions of Electrical safety, effects of shocks and their prevention.
2. Summarize the safety aspects during installation of plant and equipment.
3. Describe the electrical safety in residential, commercial and agricultural installations.
4. Describe the various Electrical safety in hazardous areas, Equipment earthing and system neutral earthing.
5. State the electrical systems safety management and IE rules.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO2	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO3	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO4	3	3	3	2	2	2	2	-	2	2	-	2	2	2
CO5	3	3	3	1	2	2	2	-	2	2	-	2	2	2

UNIT I

INTRODUCTION TO ELECTRICAL SAFETY, SHOCKS AND THEIR PREVENTION*:* Terms and definitions, objectives of safety and security measures, Hazards associated with electric current, and voltage, who is exposed, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety.

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Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops.

UNIT II

SAFETY DURING INSTALLATION OF PLANT AND EQUIPMENT:

Introduction, preliminary preparations, preconditions for start of installation work, during, risks during installation of electrical plant and equipment, safety aspects during installation, field quality and safety during erection, personal protective equipment for erection personnel, installation of a large oil immersed power transformer, installation of outdoor switchyard equipment, safety during installation of electrical rotating machines, drying out and insulation resistance measurement of rotating machines.

UNIT III

ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL AND AGRICULTURAL INSTALLATIONS: Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.

UNIT IV

ELECTRICAL SAFETY IN HAZARDOUS AREAS: Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipment for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.

UNIT V

SAFETY MANAGEMENT OF ELECTRICAL SYSTEMS: Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees.

REVIEW OF IE RULES AND ACTS AND THEIR SIGNIFICANCE:

Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage –Rules regarding first aid and fire fighting facility.
The Electricity Act, 2003, (Part1, 2, 3, 4 & 5).

Suggested Reading:

1. S.Rao, Prof. H.L.Saluja, "Electrical safety, fire safety Engineering and safety management", 1st edition Khanna Publishers. New Delhi, 2016 Reprint.

2. Pradeep Chaturvedi, "Energy management policy, planning and utilization", Concept Publishing company, New Delhi, 1997.

OE 601ME	**3D PRINTING TECHNOLOGY**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	To understand the fundamental concepts of 3D Printing, its advantages and limitations.
2.	To know the working principle, advantages, disadvantages and applications of liquid, solid and Powder based 3D Printing Technologies.
3.	To know the various types of STL file errors and other data formats used in 3D PrintingTechnology.
4	To know the features of various 3D Printing software‟s.
5	To know diversified applications of 3D Printing Technologies

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Interpret the features of 3D Printing and compare it with conventional methods.
CO-2	Illustrate the working principle of liquid, solid and powder based 3D Printing
CO-3	Identify various types of errors in STL file and other data formats used in 3D Printing Technology.
CO-4	Select suitable software used in 3D Printing Technology
CO-5	Apply the knowledge of various 3D Printing technologies for developing innovative applications.

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1														
CO2														
CO3														
CO4														
CO5														

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT-I:

Introduction: Prototyping fundamentals: Need for time compression in product development, Historical development, Fundamentals of 3D Printing, 3D Printing Process Chain, Advantages and Limitations of 3D Printing, 3D Printing wheel, Commonly used Terms, Classification of 3D printing processes, Fundamental Automated Processes: Distinction between 3D Printing and Conventional Machining Processes.

UNIT-II

Liquid-based 3D Printing Systems: Stereo Lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Polyjet: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies

Solid-based 3D Printing System: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT-III

Powder Based 3D Printing Systems: Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following 3D Printing Technologies like Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM),

UNIT-IV

3D Printing Data Formats & Software: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. 3D Printing Software"s Features: Magics, Mimics, Solid View, View Expert, 3 D Rhino, 3 D doctor, Flash Print, Object Studio, Cura, ITK Snap, 3-matic, Simplant, 3-matic, Simplant, MeshLab, Ansys for Additive Manufacturing.

UNIT-V

Applications of 3D Printing : Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Electronic Industry, Jewellery Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Biopolymers, Packaging, Disaster Management, Entertainment and Sports industry.

Suggested Reading:

1.	Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific
2.	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct DigitalManufacturing- Ian Gibson, David W Rosen, Brent Stucker, Springer, Second Edition, 2010.
3.	Rapid Prototyping & Engineering Applications – Frank W.Liou, CRC Press, Taylor & Francis Group, 2011
4.	Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, JohnWiley& Sons, 2006.

5	NPTEL Course on Rapid Manufacturing. https://nptel.ac.in/courses/112/104/112104265/

OE 602ME	**FINITE ELEMENT METHOD**					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1.	To understand the theory and application of the finite element method for analyzing structural systems.
2.	To learn Approximation theory for structural problems as the basis for finite element methods.
3.	To learn formulations for a variety of elements in one, two, and three dimensions. Implementations of element formulations will be examined using Matlab.
4	To understand modeling and analysis of structures using planar, solid, and plate elements
5	To understand the theory and application of the finite element method for analyzing structural systems.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Demonstrate a basic understanding of the concepts, mathematical formulation and numerical implementation.
CO-2	Demonstrate the ability to invoke appropriate assumptions, select proper elements and develop FEA models that adequately and efficiently represent physical systems.
CO-3	Underlying the FEA as applied to solid mechanics.
CO-4	Solve 2D vector variable problems and analyze higher order elements and its applications.
CO-5	Create his/her own FEA computer programs using Matlab to solve simple engineering problems.

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1														
CO2														
CO3														
CO4														
CO5														

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT I: INTRODUCTION

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II: ONE-DIMENSIONAL PROBLEMS

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes.

UNIT III: TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

UNIT IV: TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations – Plate and shell elements.

UNIT V: ISOPARAMETRIC FORMULATION

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Suggested Reading:

1.	Tirupathi R. Chandraputla and Ashok, D. Belgundu ”Introduction to Finite Elements in Engineering” , Pearson Education, 2002, 3 Edition.
2.	Rao S.S., “The Finite Element Methods in Engineering”, pergam on Press, 1989.
3.	Segerlind, L.J. “Applied Finite Element Analysis”, Wiley Publication, 1984.
4.	Reddy J.N., “An Introduction to Finite Element Method”, Mc Graw-Hill Company, 1984.

PC 651 CE	**ENVIRONMENTAL ENGINEERING LABORATORY**					
Pre-requisites	Fluid Mechanics		**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	50 Marks	**CIE**		25 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student	
1.	introduction to characterization of water and wastewater
2.	Knowledge of experiments for water quality assessment
3.	To verify the efficacy of some water treatment processes

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Knack to interpret and analysis the experimental data
CO-2	Ability to apply the laboratory results for providing technical solutions
CO-3	Capacity to write a technical report based on the experimental results

Articulation matrix of Course outcomes with PO's:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO 2**
CO1	3	2	-	2	1	-	-	1	2	3	-	1	2	1
CO2	3	2	-	2	1	-	-	1	2	3	-	1	2	2
CO3	3	2	-	2	1	-	-	1	2	3	-	1	2	2

Correlation rating: Low/ Medium/High:1/2/3respectively.

List of Experiments:

List of Experiments:

1. A) Determination of total dissolved solids
   B) Determination of total suspended solids
   C) Determination of fluorides
2. Determination of total hardness
3. Determination of alkalinity
4. Determination of chlorides
5. Determination of sulphates

6. Determination of MPN
7. Determination of residual chlorine
8. Determination of optimum alum dosage
9. Determination of BOD
10. Determination of COD

PW651CE	**MINI PROJECT**					
Pre-requisites			**L**	**T**	**P**	**C**
				-	3	3
Evaluation	**SEE**	50 Marks	**CIE**		-	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Identification of the research problem
2	Discussion and critical appraisal of literature review.
3	Discussion of Methodology for the research problem

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify Civil Engineering problems by reviewing available latest literature.
CO-2	Study different techniques and analyze the systems.
CO-3	Provide appropriate solutions for the identified problem & submission of the comprehensive report

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	2	2	-	1	1	2	-	1	2	2
CO2	2	2	1	-	1	1	-	-	-	-	-	-	2	1
CO3	2	2	1	-	1	1	-	-	-	-	-	-	2	1

Correlation rating: Low/ Medium/High: 1/2/3 respectively

1. Mini Project will have End Semester Evaluation. The evaluation includes Presentation containing identification of the problem based on the literature review on the topic referring to latest literature available.
2. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution. Continuous assessment of Mini Project will be monitored by the departmental committee. It should encompass components, devices, with which functional familiarity is introduced.
3. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini-project.
4. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.

5. The student is expected to exert on design, development and testing of the proposed work as per the schedule.
6. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.

PW 661CE	**SUMMER INTERNSHIP**				
Pre-requisites		**L**	**T**	**P**	**C**
		-	-	-	
Evaluation	6 Weeks, Evaluation will be done in the VII-Sem				

Course Objectives:

- To expose the students in understanding the real-life practical problems andtechnologies.
- To provide an opportunity to integrate various aspects of learning reference ofpractical problems.
- To enhance the confidence of the students by interaction with field professionals

Course Outcomes: Student will be

1. Able to design or develop a simple software suitable to industry
2. Able to complete the task or realize a prescribed target within a limited scope.
3. Able to learn to find alternate viable solutions for a given problem based on criteria.
4. Able to learn new software suitable for Civil Engineering problems.
5. Ability to learn field constraints and also documentation of technical report.

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	3	2	2	2	2	3	2	2	3	2
CO2		2	2		2	1	2	1	2	2	3	2	3	2
CO3	1	2	2		2	1	2	1	2	2	3	2	3	2
CO4	2	3	3	3	3	2	2	2	2	3	2	2	3	2
CO5		2	1					1	3	3		1	1	1

Correlation rating: Low/ Medium/High: 1/2/3 respectively

Summer Internship is introduced as part of the curricula to encourage students to workon problems of interest to industries or in a consulting organization. A batch of two or three students will be attached to Industry/ R & D Organization / National Laboratory / Consultants / Project offices/ Executing Agencies /Departments/ Private Builders for a period of SIX weeks. This will be during the summer vacation followed after the completion VI semester course. Faculty member (s) will be acting as an internal guide(s) for the batches to mentor andmonitor the progress and also interacts with the Industry guide (s) as per the need.

After the completion of the internship, students need to submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the Department. The performance of the student will be judged by internal guide (s) followed by presentation before the committee constituted by the Department. One faculty member will coordinate the overall activity of Summer Internship.

**Students have to undergo summer internship of 6 Weeks duration at the end of semester VI and evaluation will be done in VII semester.*