Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Civil Engineering

(Applicable from the academic session 2018-2019)

SEMESTER –III (2ND YR)

CE(BS)301	**Biology (Biology for Engineers)**	2L + 1T =	3 Credits
Module 1	**Introduction** Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry. **Purpose:** To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry		2L
Module 2	**Classification** Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitataacquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus **Purpose:** To convey that classification *per se* is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted.		3L
Module 3	**Genetics** Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics. **Purpose:** To convey that "Genetics is to biology what Newton's laws are to Physical Sciences"		4L
Module 4	**Biomolecules** Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids. **Purpose**: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine		4L
Module 5	**Enzymes** Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyzereactions. Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis. **Purpose:** To convey that without catalysis life would not have existed on earth		4L
Module 6	**Information Transfer** Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structurefrom single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.\ **Purpose:** The molecular basis of coding and decoding genetic information is universal		4L
Module 7	**Macromolecular analysis** Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements. **Purpose:** How to analyses biological processes at the reductionistic level		5L
Module 8	**Metabolism** Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO2 + H2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO2 and H2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge **Purpose:** The fundamental principles of energy transactions are the same in physical and biological world.		4L
Module 9	**Microbiology** Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.		3L
Reference	1) Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.;Wasserman, S. A.;		

	Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd 2) Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons 3) Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman andCompany 4) Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company,Distributed by Satish Kumar Jain for CBS Publisher 5) Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. BrownPublishers 6) Biology of Engineers, McGraw Hill (ISBN: 978-11-21439-931)	

CE(ES)301	**Engineering Mechanics**	3L + 1T =	4 Credits
Module 1	**Introduction to Engineering Mechanics** Force Systems Basic concepts, Particleequilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces,Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant ofForce System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium ofCoplanar Systems and Spatial Systems; Static Indeterminacy		6L
Module 2	**Friction** Types of friction, Limiting friction, Laws of Friction, Static andDynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack;		3L
Module 3	**Basic Structural Analysis** Equilibrium in three dimensions; Method of Sections;Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zeroforce members; Beams & types of beams; Frames & Machines;		4L
Module 4	**Centroid and Centre of Gravity** Centroid of simple figures from first principle,centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia-Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia,Moment of inertia of standard sections and composite sections; Mass moment inertia of circularplate, Cylinder, Cone, Sphere, Hook.		5L
Module 5	**Virtual Work and Energy Method-** Virtual displacements, principle of virtual work forparticle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems withfriction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational),energy equation for equilibrium. Applications of energy method for equilibrium. Stability ofequilibrium.		4L
Module 6	**Review of particle dynamics-** Rectilinear motion; Plane curvilinear motion (rectangular,path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2ndlaw (rectangular, path, and polar coordinates). Work-kinetic energy, power, potentialenergy.Impulse-momentum (linear, angular); Impact (Direct and oblique).		4L
Module 7	**Introduction to Kinetics of Rigid Bodies** Basic terms, general principles indynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems;D'Alembert's principle and its applications in plane motion and connected bodies; Work energyprinciple and its application in plane motion of connected bodies; Kinetics of rigid body rotation;		5L
Module 8	**Mechanical Vibrations** Basic terminology, free and forced vibrations,resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of freevibrations without damping and single degree of freedom system, simple problems, types ofpendulum, use of simple, compound and torsion pendulums;		5L
Tutorials	From the above modules covering, To find the various forces and angles including resultants in various parts of wall crane, roof truss, pipes, etc.; To verify the line of polygon on various forces; To find coefficient of friction between various materials on inclined plan; Free bodydiagrams various systems including block-pulley; To verify the principle of moment in the discapparatus; Helical block; To draw a load efficiency curve for a screw jack		6L
Reference	1. D.S. Bedi (2018), Engineering Mechanics, Khanna Publishing House, 2019 2. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall 3. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, –Dynamics, 9th Ed, Tata McGraw Hill 4. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press. 5. Andy Ruina and RudraPratap (2011), Introduction to Statics and Dynamics, Oxford UniversityPress 6. Shanes and Rao (2006), Engineering Mechanics, Pearson Education, 7. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education 8. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics 9. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications 10. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co. 11. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications		

CE(ES)302	**Energy Science & Engineering**	1L + 1T =	2 Credits
Module 1	**Introduction to Energy Science** Scientific principles and historical interpretation to place energy use in the context of pressing societal, environmental and climate issues; Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment. **Tutorials:**Compile a World map showing Energy Reserves by source, Total Energyconsumption, Per capita energy consumption and Carbon Footprint		3L
Module 2	**Energy Sources** Overview of energy systems, sources, transformations, efficiency, andstorage. Fossil fuels (coal, oil, oil-bearing shale and sands, coal gasification) - past, present & future,Remedies & alternatives for fossil fuels - biomass, wind, solar, nuclear, wave, tidal and hydrogen;Sustainability and environmental trade-offs of different energy systems; possibilities for energy storage or regeneration (Ex. Pumped storage hydro power projects, superconductor-based energystorages, high efficiency batteries) **Tutorials:**Compile a Word Map showing Alternative Energy sourceusage; Compile a Process diagram for a Pumped Storageproject; Collect details of a typical North Sea oil platform. Compile a map of India showing exiting potential and utilizedpotential for hydro power. List the pros and cons for Thermal,hydro, nuclear and solar power projects.		4L
Module 3	**Energy & Environment** Energy efficiency and conservation; introduction to clean energy technologies and its importance in sustainable development; Carbon footprint, energy consumptionand sustainability; introduction to the economics of energy; How the economic system determinesproduction and consumption; linkages between economic and environmental outcomes; How futureenergy use can be influenced by economic, environmental, trade, and research policy **Tutorials:**Study the functioning of an Electro Static Precipitator in athermal power plant; study the uses of coarse and fine Fly Ashfrom thermal power plants. Compile the safety provisions indesign and construction of a reactor containment building		5L
Module 4	**Civil Engineering Projects connected with the Energy Sources** Coal miningtechnologies, Oil exploration offshore platforms, Underground and under-sea oil pipelines, solarchimney project, wave energy caissons, coastal installations for tidal power, wind mill towers; hydropower stations above-ground and underground along with associated dams, tunnels, penstocks, etc.;Nuclear reactor containment buildings and associated buildings, design and construction constraintsand testing procedures for reactor containment buildings; Spent Nuclear fuel storage and disposalsystems **Tutorials:**Compile a process diagram for a typical underground hydropower project; Collect details of a model solar chimneyproject; collect details of a wave energy project at Vizhinjam;Collect details of the Kalpasar (Tidal energy) project		10L
Module 5	**Engineering for Energy conservation** Concept of Green Building and GreenArchitecture; Green building concepts (Green building encompasses everything from the choice ofbuilding materials to where a building is located, how it is designed and operated); LEED ratings;Identification of energy related enterprises that represent the breath of the industry and prioritizingthese as candidates; Embodied energy analysis and use as a tool for measuring sustainability. EnergyAudit of Facilities and optimization of energy consumption. **Tutorials:**Draw a typical geometrical orientation of a house in your areato avoid sun's radiation in the bed room in the evening;Identify typical examples of Indian buildings having variousLEED ratings; List various building materials with theirembodied energy content. Do an Energy Audit of yourDepartmental Building in the college		8L
Reference	1. O.P, Gupta, Energy Technology, Khanna Book Publishing, (2019) 2. Boyle, Godfrey (2004), Renewable Energy (2nd edition). Oxford University Press 3. Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004), Energy Systems andSustainability: Power for a Sustainable Future. Oxford University Press 4. Chakrabarti, Energy Engineering & Management, PHI 5.Schaeffer, John (2007), Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living, Gaiam 6. Jean-Philippe; Zaccour, Georges (Eds.), (2005), Energy and Environment Set: Mathematicsof Decision Making, Loulou, Richard; Waaub, XVIII, 7. Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A. (2006) Energy and the Environment, 2nd Edition, John Wiley 8. UNDP (2000), Energy and the Challenge of Sustainability, World Energy assessment 9. E H Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers,		

	Addison-Wesley Publishing Company 10. Related papers published in international journals	

CE(BS)302	**Mathematics-III (Transform & Discrete Mathematics)**	2L + 0T	2 Credits
(Prerequisite 2c, 5b-d, 6b)			
Module 1	**Transform Calculus -1** Polynomials – Orthogonal Polynomials – Lagrange's, Chebysev Polynomials; Trigonometric Polynomials;aplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions.Finding inverse Laplace transform by different methods, convolution theorem. Evaluation ofintegrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method.		6 L
Module 2	**Transform Calculus-2** Fourier transforms, Z-transform and Wavelet transforms: properties, methods, inverses and theirapplications.		6 L
Module 3	**Sets, relations and functions** Basic operations on sets, Cartesian products, disjoint union (sum), and power sets. Different types ofrelations, their compositions and inverses. Different types of functions, their compositions andinverses.		4 L
Module 4	**Propositional Logic** Syntax and semantics, proof systems, satisfiability, validity, soundness, completeness, deductiontheorem, etc. Decision problems of propositional logic. Introduction to first order logic and firstorder theory.		4 L
Module 5	**Partially ordered sets** Complete partial ordering, chain, lattice, complete, distributive, modular and complemented lattices.Boolean and pseudo Boolean lattices.		4 L
Module 6	**Algebraic Structures** Algebraic structures with one binary operation – semigroup, monoid and group. Cosets, Lagrange'stheorem, normal subgroup, homomorphic subgroup. Congruence relation and quotient structures.Error correcting code. Algebraic structures with two binary operations- ring, integral domain, andfield. Boolean algebra and boolean ring (Definitions and simple examples only).		4 L
Module 7	**Introduction to Counting** Basic counting techniques – inclusion and exclusion, pigeon-hole principle, permutation,combination, summations. Introduction to recurrence relation and generating functions.		3 L
Module 8	**Introduction to Graphs** Graphs and their basic properties – degree, path, cycle, subgraph, isomorphism, Eulerian and Hamiltonian walk, trees.		3 L
Reference	1.C. L. Liu, Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000. 2. R. C. Penner, Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999. 3. R.L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, 2nd Ed., Addison-Wesley, 1994. 4. K. H. Rosen, Discrete Mathematics and its Applications, 6th Ed., Tata McGraw-Hill, 2007. 5. J. L. Hein, Discrete Structures, Logic, and Computability, 3rd Ed., Jones and Bartlett, 2010. 6. N. Deo, Graph Theory, Prentice Hall of India, 1974. 7. S. Lipschutz and M. L. Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 1999. 8. J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill, 1997. 9. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006. 10. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010. 11. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000. 12. S.B. Singh. Discrete Structures, Khanna Publishing House, 2019 13. Veerarajan T., Engineering Mathematics, Tata McGraw-Hill, New Delhi, 2008. 14. Chandrika Prasad, Advanced Engineering Mathematics, KPB		

CE(HS)301	**Humanities-I (Effective Technical Communication)**	3L + 0T	3 Credits
Module 1	Information Design and Development- Different kinds of technical documents,Information development life cycle, Organization structures, factors affecting information anddocument design, Strategies for organization, Information design and writing for print and for onlinemedia.		4L
Module 2	Technical Writing, Grammar and Editing- Technical writing process, forms of discourse,Writing drafts and revising, Collaborative writing, creating indexes, technical writing style andlanguage. Basics of grammar, study of advanced grammar, editing strategies to achieve appropriatetechnical style. Introduction to advanced technical communication, Usability, Hunan factors,Managing technical communication projects, time estimation, Single sourcing, Localization.		8L
Module 3	Self Development and Assessment- Self assessment, Awareness, Perception andAttitudes, Values and belief, Personal goal setting, career planning, Self-esteem. Managing Time;Personal memory, Rapid reading, Taking notes; Complex problem solving; Creativity		8L
Module 4	Communication and Technical Writing- Public speaking, Group discussion, Oral;presentation, Interviews, Graphic presentation, Presentation aids, Personality Development. Writingreports, project proposals, brochures, newsletters, technical articles, manuals, official notes, businessletters, memos, progress reports, minutes of meetings, event report.		8L
Module 5	Ethics- Business ethics, Etiquettes in social and office settings, Email etiquettes,Telephone Etiquettes, Engineering ethics, Managing time, Role and responsibility of engineer, Workculture in jobs, Personal memory, Rapid reading, Taking notes, Complex problem solving,Creativity.		8L
Reference	1. David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey. New York, 2004 2. Diane Hacker, Pocket Style Manual, Bedford Publication, New York, 2003. (ISBN 0312406843) 3. Kulbhushan Kumar, Effective Communication Skills, Khanna Publishing House 4. Shiv Khera, You Can Win, Macmillan Books, New York, 2003. 5. Raman Sharma, Technical Communications, Oxford Publication, London, 2004. 6. Dale Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004. (ISBN: 07828357-4) 7. Sharma, R. and Mohan, K. Business Correspondence and Report Writing, TMH New Delhi 2002. 8. Xebec, Presentation Book, TMH New Delhi, 2000. (ISBN 0402213)		

CE(HS)302	**Introduction to Civil Engineering**	1L + 1T=	2 Credits
Module 1	**Basic Understanding**: What is Civil Engineering/ Infrastructure? Basics of Engineering and Civil Engineering; Broad disciplines of Civil Engineering; Importance of Civil Engineering, Possible scopes for a career **Tutorials** Develop a matrix of various disciplines and possibleroles for engineers in each		1 L
Module 2	**History of Civil engineering**: Early constructions and developments over time; Ancient monuments & Modern marvels; Development of various materials of construction and methods of construction; Works of Eminent civil engineers **Tutorials** Identify 10 ancient monuments and ten modern marvels and list the uniqueness of each		1 L
Module 3	**Overview of National Planning for Construction and Infrastructure Development**; Positionof construction industry vis-à-vis other industries, five year plan outlays for construction; currentbudgets for infrastructure works **Tutorials** Develop a Strategic Plan for Civil Engineering worksfor next ten years based on past investments andidentify one typical on-going mega project in eacharea		1 L
Module 4	**Fundamentals of Architecture & Town Planning**: Aesthetics in Civil Engineering, Examples of great architecture, fundamentals of architectural design & town planning; BuildingSystems (HVAC, Acoustics, Lighting, etc.); LEED ratings; Development of Smart cities **Tutorials** Identify ten best civil engineering projects with highaesthetic appeal with one possible factor for each; Listdown the possible systems required for a typical SmartCity		1 L
Module 5	**Fundamentals of Building Materials**: Stones, bricks, mortars, Plain, Reinforced &PrestressedConcrete, Construction Chemicals; Structural Steel, High Tensile Steel, Carbon Composites;Plastics in Construction; 3D printing; Recycling of Construction & Demolition wastes **Tutorials** Identify three top new materials and their potential inconstruction; Visit a Concrete Lab and make a report		2 L
Module 6	**Basics of Construction Management & Contracts Management**: Temporary Structures in Construction; Construction Methods for various types of Structures; Major Construction equipment; Automation & Robotics in Construction; Modern Project management Systems; Advent of Lean Construction; Importance of Contracts Management **Tutorials** Identify 5 typical construction methods and list theiradvantages/ positive features		2 L
Module 7	**Environmental Engineering & Sustainability**: Water treatment systems; Effluent treatment systems; Solid waste management; Sustainability in Construction **Tutorials** Sustainability principles, Sustainable builtenvironment, water treatment systems, and good practicesof wastewater management. examples of Solid andhazardous waste management, Air pollution andcontrol		2L
Module 8	**Geotechnical Engineering**: Basics of soil mechanics, rock mechanics and geology; various types of foundations; basics of rock mechanics & tunnelling **Tutorials** List top five tunnel projects in India and their features;collect and study geotechnical investigation report ofany one Metro Rail (underground) project; Visit aconstruction site and make a site visit report		2 L
Module 9	**Hydraulics, Hydrology &Water Resources Engineering**: Fundamentals of fluid flow, basics ofwater supply systems; Underground Structures; Underground Structures Multi-purpose reservoirprojects **Tutorials** Identify three river interlinking projects and theirfeatures; visit a Hydraulics Lab and make a report		1 L
Module 10	**Ocean Engineering**: Basics of Wave and Current Systems; Sediment transport systems; Ports &Harbours and other marine structures **Tutorials** Identify 5 typical ports in India and list the structuresavailable in them; Visit a related/similar facility, ifpossible in nearby place and make a report		1 L
Module 11	**Power Plant Structures**: Chimneys, Natural & Induced Draught Colling towers, coal handling		1 L

	systems, ash handling systems; nuclear containment structures; hydro power projects **Tutorials** Collect the typical layout for a large thermal powerplant and a large hydro power plant and identify all thestructures and systems falling in them.	
Module 12	**Structural Engineering**: Types of buildings; tall structures; various types of bridges; Water retaining structures; Other structural systems; Experimental Stress Analysis; Wind tunnel studies; **Tutorials** Identify 5 unique features for typical buildings,bridges, tall structures and large span structures; VisitStructures Testing Lab/facility and make a report	3 L
Module 13	**Surveying & Geomatics**: Traditional surveying techniques, Total Stations, Development of Digital Terrain Models; GPS, LIDAR; **Tutorials** Collect visual representations prepared by a TotalStation and LIDAR and compare; Study typicalGoogle street map and Google Earth Map and studyhow each can facilitate the other	1 L
Module 14	**Traffic &Transportation Engineering**: Investments in transport infrastructure development inIndia for different modes of transport; Developments and challenges in integrated transport development in India: road, rail, port and harbour and airport sector; PPP in transport sector; Intelligent Transport Systems; Urban Public and Freight Transportation; Road Safety underheterogeneous traffic; Sustainable and resilient pavement materials, design, construction andmanagement; Case studies and examples. **Tutorials** Investments in transport infrastructure; Developmentsand challenges; Intelligent Transport Systems; SmartCities, Urban Transport; Road Safety; Sustainable andresilient highway design principles; Plan a sustainabletransport system for a city; Identify keyfeatures/components in the planning and design of agreen field highway/airport/port/railway and the cost –economics.	1 L
Module 15	**Repairs & Rehabilitation of Structures:** Basics of corrosion phenomena and other structural distress mechanisms; some simple systems of rehabilitation of structures; Non-Destructivetesting systems; Use of carbon fibre wrapping and carbon composites in repairs. **Tutorials** Collect the history of a major rehabilitation project andlist the interesting features	1 L
Module 16	**Computational Methods, IT, IoT in Civil Engineering:** Typical software used in Civil Engineering- Finite Element Method, Computational Fluid Dynamics; Computational Geotechnical Methods; highway design (MX), Building Information Modelling; Highlighting typical available software systems (SAP, STAAD, ABAQUS, MATLAB, ETAB, NASTRAN, NISA, MIKE 21, MODFLOW, REVIT, TEKLA, AUTOCAD,…GEOSTUDIO, EDUSHAKE, MSP, PRIMAVERA, ArcGIS, VisSIM, …) **Tutorials** Visit an AutoCad lab and prepare a report; Identify teninteresting software systems used in Civil Engg andtheir key features	2 L
Module 17	**Industrial lectures**: Case studies of large civil engineering projects by industry professionals, covering comprehensive planning to commissioning; **Tutorials** For each case study list the interesting features	2 L
Module 18	**Basics of Professionalism**: Professional Ethics, Entrepreneurial possibilities in Civil Engineering, Possibilities for creative & innovative working, Technical writing Skills enhancement; Facilities Management; Quality & HSE Systems in Construction	3 L
Tutorials	List 5 cases of violation of professional ethics and listpreventive measures; Identify 5 interesting projectsand their positive features; Write 400 word reports on one ancient monument and a modern marvel of civilengineering	5L
Reference	1. Patil, B.S.(1974), Legal Aspects of Building and Engineering Contract 2. The National Building Code, BIS, (2017) 3. RERA Act, (2017) 4. Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset 5. Chandiramani, Neelima (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications Mumbai 6. Avtarsingh (2002), Law of Contract, Eastern Book Co. 7. Dutt (1994), Indian Contract Act, Eastern Law House 8. Anson W.R.(1979), Law of Contract, Oxford University Press 9. Kwatra G.K.(2005), The Arbitration & Conciliation of Law in India with case law on UNCITRAL Model Law on Arbitration, Indian Council of Arbitration 10. Avtarsingh (2005), Law of Arbitration and Conciliation, Eastern Book Co. 11. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co. 12. P. S. Narayan (2000), Intellectual Property Rights, Gogia Law Agency	

	13. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House 14. Bare text (2005), Right to Information Act 15. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers 16. K.M. Desai(1946), The Industrial Employment (Standing Orders) Act 17. Rustamji R.F., Introduction to the Law of Industrial Disputes, Asia Publishing House 18. Vee, Charles &Skitmore, Martin (2003) Professional Ethics in the Construction Industry, Engineering Construction and Architectural management, Vol.10, Iss. 2, pp 117-127, MCB UP Ltd 19. American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application 20. Ethics in Engineering- M.W.Martin&R.Schinzinger, McGraw-Hill 21. Engineering Ethics, National Institute for Engineering Ethics, USA 22. www.ieindia.org 23. Engineering ethics: concepts and cases – C. E. Harris, M.S. Pritchard, M.J.Rabins 24. Resisting Bureaucratic Corruption: Alacrity Housing Chennai (Teaching Case Study) -S. Ramakrishna Velamuri -CEIBS 25. CONSTRUCTION CONTRACTS, http://www.jnormanstark.com/contract.htm 26. Internet and Business Handbook, Chap 4, CONTRACTS LAW, http://www.laderapress.com/laderapress/contractslaw1.html 27. Contract &Agreements , http://www.tco.ac.ir/law/English/agreements/General/Contract%20Law/C.htm 28. Contracts, http://206.127.69.152/jgretch/crj/211/ch7.ppt 29. Business & Personal Law. Chapter 7. “How Contracts Arise”, http://yucaipahigh.com/schristensen/lawweb/lawch7.ppt 30. Types of Contracts, http://cmsu2.cmsu.edu/public/classes/rahm/meiners.con.ppt 31. IV. TYPES OF CONTRACTS AND IMPORTANT PROVISIONS, http://www.worldbank.org/html/opr/consult/guidetxt/types.html 32. Contract Types/Pricing Arrangements Guideline- 1.4.G (11/04/02), http://www.sandia.gov/policy/14g.pdf	

LABORATORY/ SESSIONAL

CE(ES)391	**Basic Electronics**	1L + 2P	2 Credits
Theory			
Module 1	Diodes and Applications covering, Semiconductor Diode - Ideal versus Practical, Resistance Levels, Diode Equivalent Circuits, Load Line Analysis; Diode as a Switch, Diode as aRectifier, Half Wave and Full Wave Rectifiers with and without Filters; Breakdown Mechanisms, Zener Diode – Operation and Applications; Opto-Electronic Devices – LEDs, Photo Diode and Applications; Silicon Controlled Rectifier (SCR) – Operation, Construction, Characteristics, Ratings,Applications;		4L
Module 2	Transistor Characteristics covering, Bipolar Junction Transistor (BJT) – Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Operating Point, Voltage Divider Bias Configuration; Field Effect Transistor (FET)– Construction, Characteristics of Junction FET, Depletion and Enhancement type Metal OxideSemiconductor (MOS) FETs, Introduction to CMOS circuits;		4L
Module 3	Transistor Amplifiers and Oscillators covering, Classification, Small Signal Amplifiers – Basic Features, Common Emitter Amplifier, Coupling and Bypass Capacitors, Distortion, AC Equivalent Circuit; Feedback Amplifiers – Principle, Advantages of Negative Feedback, Topologies,Current Series and Voltage Series Feedback Amplifiers; Oscillators – Classification, RC Phase Shift, Wien Bridge, High Frequency LC and Non-Sinusoidal type Oscillators;		4L
Module 4	Operational Amplifiers and Applications covering, Introduction to Op-Amp, Differential Amplifier Configurations, CMRR, PSRR, Slew Rate; Block Diagram, Pin Configuration of 741 Op-Amp, Characteristics of Ideal OpAmp, Concept of Virtual Ground;		4L
Practical			
Module 1	Laboratory Sessions covering, Identification, Specifications, Testing of R, L, C Components (Colour Codes), Potentiometers, Switches (SPDT, DPDT and DIP), Bread Boards andPrinted Circuit Boards (PCBs); Identification, Specifications, Testing of Active Devices – Diodes,BJTs, JFETs, MOSFETs, Power Transistors, SCRs and LEDs;		
Module 2	Study and Operation of Digital Multi Meter, Function / Signal Generator, Regulated Power Supply (RPS), Cathode Ray Oscilloscopes; Amplitude, Phase and Frequency of SinusoidalSignals using Lissajous Patterns on CRO; (CRO);		
Module 3	Experimental Verification of PN Junction Diode Characteristics in A) Forward Bias B) Reverse Bias, Zener Diode Characteristics and Zener Diode as Voltage Regulator, Input and OutputCharacteristics of BJT in Common Emitter (CE) Configuration, Drain and Transfer Characteristics of JFET in Common Source (CS) Configuration;		
Module 4	Study of Half Wave and Full Wave Rectification, Regulation with Filters, Gain and Bandwidth of BJT Common Emitter (CE) Amplifier, Gain and Bandwidth of JFET Common		

	Source(CS) Amplifier, Gain and Bandwidth of BJT Current Series and Voltage Series Feedback Amplifiers,Oscillation Frequency of BJT based RC Phase Shift, Hartley and Colpitts Oscillators;	
Module 5	Op-Amp Applications – Adder, Subtractor, Voltage Follower and Comparator; Op-Amp Applications – Differentiator and Integrator, Square Wave and Triangular Wave Generation, Applications of 555 Timer – Astable and MonostableMultivibrators;	
Module 6	Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR Integrated Circuits (ICs); Truth Tables and Functionality of Flip-Flops – SR, JK and DFlip-Flop ICs; Serial-In-Serial-Out and Serial-In-Parallel-Out Shift operations using 4-bit/8-bit ShiftRegister ICs; Functionality of Up-Down / Decade Counter ICs;	
Reference	1. David. A. Bell (2003), Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India 2. SantiramKal (2002), Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India 3. Thomas L. Floyd and R. P. Jain (2009), Digital Fundamentals by Pearson Education, 4. Paul B. Zbar, A.P. Malvino and M.A. Miller (2009), Basic Electronics – A Text-Lab. Manual, TMH 5. R.T. Paynter (2009), Introductory Electronic Devices & Circuits, Conventional Flow Version, Pearson	

CE(ES)392	**Computer-aided Civil Engineering Drawing**	1L + 2P	2 Credits
Module 1	**INTRODUCTION** Introduction to concept of drawings, Interpretation of typicaldrawings, Planning drawings to show information concisely and comprehensively; optimallayout of drawings and Scales; Introduction to computer aided drawing, co-ordinate systems,reference planes. Commands: Initial settings, Drawing aids, Drawing basic entities, Modifycommands, Layers, Text and Dimensioning, Blocks. Drawing presentation norms andstandards.		2 L
Module 2	**SYMBOLS AND SIGN CONVENTIONS** Materials, Architectural, Structural, Electricaland Plumbing symbols. Rebar drawings and structural steel fabrication and connections drawingsymbols, welding symbols; dimensioning standards		2 L
Module 3	**MASONRY BONDS** English Bond and Flemish Bond – Corner wall and Cross walls -One brick wall and one and half brick wall		1 L
Module 4	BUILDING DRAWING Terms, Elements of planning building drawing, Methods ofmaking line drawing and detailed drawing. Site plan, floor plan, elevation and section drawingof small residential buildings. Foundation plan. Roof drainage plans. Depicting joinery, standardfittings & fixtures, finishes. Use of Notes to improve clarity		5 L
Module 5	PICTORIAL VIEW Principles of isometrics and perspective drawing. Perspective viewof building. Fundamentals of Building Information Modelling (BIM)		2 L
Drawings			
1	Buildings with load bearing walls including details of doors and windows.		6P
2	Taking standard drawings of a typical two storeyed building including all MEP,joinery, rebars, finishing and other details and writing out a description of theFacility in about 500-700 words		4P
3	RCC framed structures		6P
4	Reinforcement drawings for typical slabs, beams, columns and spread footings		6P
5	Industrial buildings - North light roof structures – Trusses		4P
6	Perspective view of one and two storey buildings		4P
Reference	1. Subhash C Sharma &Gurucharan Singh (2005), "Civil Engineering Drawing", Standard Publishers 2. Pradeep Jain & A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House (2019) 3. Ajeet Singh (2002), "Working with AUTOCAD 2000 with updates on AUTOCAD 200I", Tata- Mc Graw-Hill Company Limited, New Delhi 4. Sham TickooSwapna D (2009), "AUTOCAD for Engineers and Designers", Pearson Education, 5. Venugopal (2007), "Engineering Drawing and Graphics + AUTOCAD", New Age International Pvt. Ltd., 6. Shah, Engineering Drawings and Computers, Pearson 7. Balagopal and Prabhu (1987), "Building Drawing and Detailing", Spades publishing KDR building, Calicut, 8. (Corresponding set of) CAD Software Theory and User Manuals.		

	9. Malik R.S., Meo, G.S. (2009) Civil Engineering Drawing, Computech Publication Ltd New Asian. 10. Sikka, V.B. (2013), A Course in Civil Engineering Drawing, S.K.Kataria& Sons,	

CE(ES)393	Life Science	1L + 2P	2 Credits
Module 1A	**Plant Physiology** Transpiration; Mineral nutrition		3 L
Module 1B	**Ecology** Ecosystems- Components, types, flow of matter and energy in anecosystem; Community ecology- Characteristics, frequency, life forms, and biological spectrum;Ecosystem structure- Biotic and a-biotic factors, food chain, food web, ecological pyramids;		3 L
Module 2A	**Population Dynamics** Population ecology- Population characteristics,ecotypes; Population genetics- Concept of gene pool and genetic diversity in populations,polymorphism and heterogeneity;		3 L
Module 2B	**Environmental Management** Principles: Perspectives, concerns andmanagement strategies; Policies and legal aspects- Environment Protection Acts and modification,International Treaties; Environmental Impact Assessment- Case studies (International Airport,thermal power plant);		3 L
Module 3A	**Molecular Genetics** Structures of DNA and RNA; Concept of Gene, Generegulation, e.g., Operon concept		3 L
Module 3B	**Biotechnology** Basic concepts: Totipotency and Cell manipulation; Plant &Animal tissue culture- Methods and uses in agriculture, medicine and health; Recombinant DNATechnology- Techniques and applications		3 L
Module 4	**Biostatistics** Introduction to Biostatistics:-Terms used, types of data;Measures of Central Tendencies- Mean, Median, Mode, Normal and Skewed distributions; Analysisof Data- Hypothesis testing and ANNOVA (single factor)		4 L
Module 5	**Laboratory & FieldworkSessions** Comparison of stomatal index in differentplants; Study of mineral crystals in plants; Determination of diversity indices in plant communities;To construct ecological pyramids of population sizes in an ecosystem; Determination of ImportanceValue Index of a species in a plant community; Seminar (with PPTs) on EIA of a Mega-Project (e.g.,Airport, Thermal/Nuclear Power Plant/ Oil spill scenario); Preparation and extraction of genomic DNA and determination of yield by UV absorbance; Isolation of Plasmid DNA and its separation byGel Electrophoresis; Data analysis using Bio-statistical tools;		**15 P**
References	1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd 2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H. John Wiley and Sons 3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company 4. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R. W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher 5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers 6. Life Sciences, Vol. I & II, Pathfinder Publications		

Semester IV [Second year]

CE(ES)401	Introduction to Fluid Mechanics	2L + 0T	2 Credits
Course Outcome	On successful completion of this course, student should be able to: 1. define basic terms, values and laws in the areas of fluids properties, statics, kinematics and dynamics of fluids, and hydraulic design of pipe systems; 2. describe methods of implementing fluid mechanics laws and phenomena while analyzing the operational parameters of hydraulic problems; 3. practically apply tables and diagrams, and equations that define the associated laws; 4. calculate and optimize operational parameters of hydraulic problems; 5. explain the correlation between different operational parameters; 6. select engineering approach to problem solving based on the acquired physics and mathematical knowledge.		
Prerequisite	Introduction to Civil Engineering, Physics.		
Module 1	**Properties of fluids:** Fluid – definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, capillarity and surface tension.		3L
Module 2	**Fluid statics:** Pressure at a point, basic equation for pressure field, pressure variation in a fluid at rest- incompressible fluid, compressible fluid, absolute pressure, gauge pressure; pressure measurements by manometers – general, inclined, inverted, micro-manometer; pressure and forces on submerged planes and curved surfaces, centre of pressure, buoyancy and floatation, Stability of submerged and floating bodies, metacentric height.		4L
Module 3:	**Fluid Kinematics:** The velocity field, Eulerian and Lagrangian flow descriptions, concepts of: - one-, two- and three-dimensional flows, steady and unsteady flows, streamlines, streaklines, pathlines; The acceleration field; Control volume and system representation, Continuity Equation, Momentum Equation, Moment-of-momentum equation, applications to pipe bends.		6L
Module 4:	**Fluid Dynamics:** Application of Newton's Law along a streamline, Bernoulli Equation, Kinetic energy head, potential energy head and pressure energy head, total energy head, Pitot tube, Examples of use of Bernoulli Equation, measurement of flows - venturimeter, energy line and hydraulic grade line.		7L
Module 5:	**Dimensional Analysis:** Buckingham Pi Theorem, determination of Pi terms, correlation of experimental data, examples.		3L
Module 6	**Flow through Pipes:** Laminar flow, Reynolds number, critical velocity, turbulent flow, shear stress at pipe wall, velocity distribution, loss of head for laminar flow, Darcy-Weisbach Formula, friction factor, contraction and expansion head losses. Concept of boundary layer and its growth.		7L
Module 7	**Pipeline Systems:** Pipes in series, pipes in parallel, equivalent pipes, branching pipes, pipe networks.		7L
Module 8	**Hydraulic Machines:** Basics of hydraulic machines, specific speed of pumps and turbines.		3L

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	A Textbook of Fluid Mechanics	R. K. Bansal	Laxmi Publications (P) Ltd., New Delhi.
	2	Hydraulics & Fluid Mechanics Including Hydraulics Machines	P. N. Modi and S. M. Seth	Standard Book House, New Delhi, 2017.
	3	Introduction to Fluid Mechanics and Fluid Machines	S. K. Som, G. Biswas and S. Chakraborty	Tata McGraw Hill Education Private Limited, New Delhi, 2012.
	4	Fluid Mechanics	F. M. White	Tata McGraw Hill Education India Private Limited, 2017.
	5	Fluid Mechanics and Hydraulic Machines	K. Subramanya	McGraw Hill Education (India)

CE(ES)402	**Introduction to Solid Mechanics**	2L + 0T	2 Credits

Course Outcome	After going through this course, the students will be able to: **1.** To identify the equilibrium conditions and elastic properties of axially loaded bars through stress-strain and force-displacement curves. **2.** To identify the principal plane and principal stresses through Mohr circle. **3.** To calculate the hoop and meridional stresses in thin cylinders and spherical shells. **4.** To identify different degrees of freedoms for support conditions like hinge, roller and fixed constraints. **5.** To calculate the bending moment, shear force and deflection of beams for uniformly distributed, concentrated, linearly varying and external concentrated moment. **6.** To calculate the member forces in a plane truss using Method of Joint and Method of Section. **7.** To identify torsional moment and twist on a circular shaft and calculate the shear stress. **8.** To know the concepts of strain energy due to axial load, bending and shear. **9.** To calculate the buckling load of columns using Euler's theory for different support constraints
Prerequisite	Engineering Mechanics (CE(ES)301), Basic Calculus

Module 1	**Review of Basic Concepts of Stress and Strain:** Normal stress, Shear stress, Bearing stress, Normal strain, Shearing strain; Hooke's law; Poisson's ratio; Stress-strain diagram of ductile and brittle materials; Elastic limit; Ultimate stress; Yielding; Modulus of elasticity; Factor of safety, Beam Statics: Support reactions, concepts of redundancy, axial force, shear force and bending moment diagrams for concentrated, uniformly distributed, linearly varying load, concentrated moments in simply supported beams, cantilever and overhanging beams	6L
Module 2	**Symmetric Beam Bending**: Basic kinematic assumption, moment of inertia, elastic flexure formulae and its application, Bending and shear stress for regular sections, shear centre	3L
Module 3:	**Deflection of statically determinate beams**: Fundamental concepts: Elastic curve, moment Curvature relationship, governing differential equation, boundary conditions: Direct integration solution	4L
Module 4:	**Analysis of determinate plane trusses**: Concepts of redundancy, Analysis by method of joints, method of sections	4L
Module 5:	**Two Dimensional Stress Problems**: Principal stresses, maximum shear stresses, Mohr's circle of stresses, construction of Mohr's circle	3L
Module 6	**Introduction to thin cylindrical & spherical shells**: Hoop stress and meridional - stress and volumetric changes	3L
Module 7	**Torsion**: Pure torsion, torsion of circular solid shaft and hollow shafts, torsional equation, torsional rigidity, closed coil helical; springs	4L
Module 8	**Columns:** Fundamentals, criteria for stability in equilibrium, column buckling theory, Euler's load for columns with different end conditions, limitations of Euler's theory – problems, eccentric load and secant formulae.	3L

Reference

Sl.	**Book Name**	**Author**	**Publishing House**
1	Elements of Strength of Material	S. P. Timoshenko and D. H. Young	EWP Pvt. Ltd
2	Mechanics of Material	R.C. Hibbeler	Pearson
3	Mechanics of Material	Beer, Jhonston, DeWolf, Mazurek	McGrawHill Education
4	Strength of Materials	R. Subramanian	OXFORD University Press
5	Strength of Materials	S S Bhavikatti	Vikas Publishing House Ltd
6	Strength of Materials	R.K. Bansal	Laxmi Publication
7	Fundamentals of Strength of Material	Nag & Chandra	WIE

CE(PC)401	**Soil Mechanics – I**	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Classify soil as per grain size distribution curve and understand the index properties of soil. **2.** Apply the concept of total stress, effective stress and pore water pressure for solving geotechnical problems. **3.** Assess the permeability of different types of soil and solve flow problems. **4.** Estimate the seepage loss, factor of safety against piping failure using flow net related to any hydraulic structure. **5.** Determine vertical stress on a horizontal plane within a soil mass subjected to different types of loading on the ground surface and also the maximum stressed zone or isobar below a loaded area. **6.** Apply the concept of shear strength to analyze different geotechnical problems and determine the shear strength parameters from lab and field tests.		
Prerequisite	Engineering Mechanics		
Module 1	**PHYSICAL PROPERTIES OF SOILS:** **Soil Formation** Introduction, Origin of Soil, Formation and Types of soil, Formative classification, Typical Indian Soil, Some Special Types of Soils, Structure and Composition, Clay Mineralogy. **Soil as a Three Phase System** Basic Definitions, Weight - Volume Relationship, Measurement of Physical Properties of Soil: Insitu Density, Moisture Content, Specific Gravity, Relative density, Functional Relationships. **Index Properties of Soil** Introduction, Particle Size Distribution, Mechanical Analysis - Sieve Analysis, Sedimentation Analysis – Hydrometer and Pipette Methods. Consistency of Soil – Atterberg Limits, Different Indices, Discussion on Limits and Indices. **Classification of Soil** Classification by Structure, Particle Size Classification, Textural System, PRA System (AASHTO Classification), Unified Classification System, As per IS Code Recommendation, Field Identification of Soil, Classification by Casagrande's Plasticity Chart.		10L + 5T
Module 2	**Soil Hydraulics** Modes of Occurrence of Water in Soil – Free Water, Held Water, Structural Water, Capillary Water, Gravitational Water, Adsorbed Water, Pore Water, Pore Water Pressure, Effective Pressure, Total Pressure, Effective Pressure under Different Conditions and in Different Cases of Flow through Soils, Critical Hydraulic Gradient, Quick Sand Condition.		3L + 1T
Module 3:	**Permeability** Introduction, Darcy's Law, Coefficient of Permeability, Discharge Velocity, Seepage Velocity, Factors Affecting Permeability. Determination of Coefficient of Permeability – Constant Head and Falling Head Methods, Permeability of Stratified Soil Deposits, Field Determination of Permeability – Unconfined and Confined Aquifers.		3L + 1T
Module 4:	**Seepage Analysis** Introduction, Seepage, Seepage Pressure, Two Dimensional Flow, Laplace's Equations, Continuity equation, Flow Nets, Flow through Earthen Dam, Estimation of Seepage, Construction, Properties and Use of Flow Nets, Piping and Heaving, Uplift due to Seepage, Design of Fillers.		3L + 1T
Module 5:	**STRESS DISTRIBUTION IN SOILS** Introduction, Geostatic Stress, Boussinesq's Equation, Determination of Stress due to Point Load, Vertical Stress Distribution on a Horizontal Plane, Isobar and Pressure Bulb, Vertical Stress Distribution on a Vertical Plane, Vertical Stress under Uniformly Loaded Circular Area, Vertical Stress Beneath a Corner of a Rectangular Area, Equivalent Point Load Method, 2:1 Method, Newmark's Influence Chart, Vertical Stress Beneath Line and Strip Loads. Westergaard Analysis, Comparison of Boussinesq and Westergaard Theories, Contact Pressure.		4L + 2T
Module 6	**SHEARING STRENGTH OF SOILS** Shear Strength of Soil Introduction, Basic Concept of Shear Resistance and Shear Strength of Soil, Mohr Circle of Stress, Sign Conventions, Mohr - Coulomb Theory, Relationship between Principal Stresses and Cohesion. Determination of Shear Parameters of Soil Stress Controlled and Strain Controlled Tests, Laboratory Determination of Soil Shear Parameters- Direct Shear Test, Triaxial Test, Classification of Shear Tests Based on Drainage Conditions, Unconfined Compression Test, Vane Shear Test as per Relevant IS Codes. Stress- Strain Relationship of Clays and Sands, Concept of Critical Void Ratio. Skempton's Pore Pressure Parameters. Sensitivity and Thixotropy of clay. Concept of Stress		5L + 3T

	path.			
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Textbook of Soil Mechanics and Foundation Engineering (Geotechnical Engineering Series)	V.N.S. Murthy	CBS Publishers
	2	Soil Mechanics and Foundations	Punmia, B.C. and Jain A. K	Laxmi Publications (P) Ltd
	3	Basic and Applied Soil Mechanics	Gopal Ranjan & A.S.R. Rao	New Age International Pvt.Ltd, Publishers
	4	Principles of Geotechnical Engineering	B.M. Das	Thomson Brooks / Cole

CE(PC)402	**Environmental Engineering – I**	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: 1. Define the basic concepts and terminologies of water supply engineering and solid waste management 2. Describe different surface and groundwater sources; and composition and characteristics of municipal solid waste 3. Apply the methods of quantifying water requirement and MSW generation 4. Solve different mathematical problems regarding different components of water supply systems, distribution networks and MSW management systems 5. Compare between different water samples based on their physical, chemical and biological characteristics 6. Design different unit processes and operations involved in water treatment and MSW management		
Prerequisite	Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Engineering Mechanics, Fluid Mechanics and Hydraulics		
Module 1	**Water Requirement Estimation** Water Demand: Different types of water demand; Per capita demand; Variations in demand; Factors affecting water demand Future Demand Forecasting: Design period; Population forecasting methods		2L + 2T
Module 2	**Sources of Water** Surface Water Sources; Ground Water Sources		4L + 2T
Module 3:	**Water Quality** Water Quality Characteristics: Physical, Chemical, and Biological parameters Drinking Water Standards: BIS; WHO; USEPA Water Quality Indices: Basic concept and examples		4L + 2T
Module 4:	**Water Treatment** Typical flow chart for surface and groundwater treatments Unit Operation and Processes: Aeration, Plain Sedimentation, Sedimentation with Coagulation and Flocculation, Water Softening, Filtration, Disinfection		9L + 3T
Module 5:	**Water Conveyance and Distribution** Hydraulic design of pressure pipes; Analysis of distribution network; Storage and distribution reservoirs; Capacity of reservoirs.		4L + 2T
Module 6	**Characteristics of Municipal Solid Waste (MSW)** Composition and characteristics of MSW		1L + 1T
Module 7	**Handling of MSW** Generation, collection and transportation of MSW		1L + 1T
Module 8	**Engineered Systems for MSW Management** Methods of reuse/ recycle, energy recovery, treatment and disposal of MSW		3L + 1T

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Environmental Engineering. Volume-1 and Volume-2	Garg, S.K.	Khanna Publishers
	2	Environmental Engineering	Peavy, H.S, Rowe, D.R, Tchobanoglous, G	Tata McGraw Hill Indian Edition
	3	Introduction to Environmental	Masters, G.M., Ela,	Prentice Hall / Pearson

		Engineering and Science	W.P.	
	4	Manual on Water Supply and Treatment	CPHEEO	Govt. of India
	5	Manual on Municipal Solid Waste Management.	CPHEEO	Govt. of India

CE(PC)403	**Surveying & Geomatics**		2L + 1T	3 Credits
Course Outcome	Upon completing the course, the students will be able to: **1.** Define and state the scope of surveying and geomatics in civil engineering **2.** Understand the basic principles of surveying and geomatics engineering **3.** Apply the different methods of surveying and geomatics to measure the features of interest **4.** Analyze the traditional and advanced methods of surveying **5.** Evaluate the different techniques of surveying and geomatics in solving real world problems. **6.** Design and construct solutions for real world problems related to surveying and geomatics.			
Prerequisite	Knowledge of Mathematics and Physics in Class-XII			
Module 1	**Principles of Surveying:** Introduction, Principles and classification of surveying; Concept of scales; Survey stations and lines – ranging and bearing; Chain surveying – Concept, Instruments, numerical problems on errors due to incorrect chain; Plane table surveying – Advantages, disadvantages, parts, methods; Elements of simple and compound curves.			4L + 2T
Module 2	**Levelling:** Levelling – Principles, Precautions and Difficulties; Differential levelling, -- Concepts and numerical problems; Contouring.			3L + 1T
Module 3:	**Triangulation and Trilateration**: Theodolite survey – Instruments, measurements of horizontal and vertical angles; Triangulation – Network, signals, numerical examples; Baseline measurement – site selection, measuring equipments, numerical problems on baseline corrections; Trigonometric levelling – Axis signal correction.			4L + 2T
Module 4:	**Advanced Surveying**: Principle of Electronic Distance Measurement (EDM); Types of EDM instruments; Distomats; Total Station – Parts, advantages, applications, field procedure and errors; Global Positioning System (GPS) – Concept, applications, segments, location determination, errors; Principle of Differential GPS; Terrestrial laser scanner.			3L + 2T
Module 5:	**Photogrammetric Surveying**: Concept; Classification of photogrammetric surveying – terrestrial, aerial and satellite; scale of a vertical photograph; relief displacement and object height determination; Stereoscopic vision – depth perception, parallactic angle, stereoscopes; Object height determination using parallax; Parallax bar; Flight planning – Concept and numerical problems; Photo mosaic; Orthophotography; Stereoscopic plotting instruments.			4L + 2T
Module 6	**Remote Sensing**: Energy sources and radiation principles; Concept of Electromagnetic Spectrum; Energy interactions in the atmosphere and earth surface features; Data acquisition and interpretation; Platforms and sensors – Geostationary and sun-synchronous orbits, pushbroom and whiskbroom scanning system, characteristics of IRS, Landsat and Sentinel sensors; Visual image interpretation			3L + 2T
Module 7	**Digital Image Processing**: Concept; Image rectification and restoration; Image enhancement; Image classification; Accuracy assessment and post classification smoothing.			4L + 2T
Module 8	**Applications of Geomatics in Civil Engineering**: 3D mapping; Earthquake and landslides; Runoff modelling; Groundwater targeting; Flood risk assessment; Urban planning; Highway and transportation			3L + 1T
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Surveying & Levelling	N. N. Basak	McGraw Hill Education (India) Private Limited
	2	Surveying – Vol. I, II & III	B. C. Punmia Ashok Kumar Jain Arun Kumar Jain	Laxmi Publications (P) Ltd.
	3	Surveying – Vol. I & II	S. K. Duggal	McGraw Hill Education (India) Private Limited
	4	Surveying & Levelling – Part I & II	T. P. Kanetkar S. V. Kulkarni	Pune Vidyarthi Griha Prakashan
	5	Remote Sensing and Image	Thomas M. Lillesand	Wiley India Edition

		Interpretation	Ralph W. Kiefer Jonathan W. Chipman	
	6	Remote Sensing and GIS	Basudeb Bhatta	Oxford University Press
	7	Applications of Geomatics in Civil Engineering	J. K. Ghosh I. de Silva (Eds.)	Springer

CE(PC)404	**Concrete Technology**			2L + 1T	3 Credits
Course Outcome	On completion of the course, the students will be able to: **1.** test all the required properties of concrete materials as per IS code. **2.** compute the properties of concrete at fresh and hardened state. **3.** design the concrete mix as per latest IS code methods. **4.** ensure quality control while testing/ sampling. **5.** Design the special type of concrete for specific application purposes. **6.** Use the admixture as per requirement.				
Prerequisite	Introduction to Civil Engineering CE(HS)302, Chemistry BS-CH101.				
Module 1	**Cement:** Manufacturing of cement, Oxides composition of cement and the calculation of compounds, Heat of hydration, Types of cement-OPC, RPC. Low heat cement, PPC, PSC, Sulphate resisting cement, High Alumina cement, Expansive cement, White cement; Test on cement- fineness, consistency, initial setting time & final setting time, soundness test, strength test, specific gravity of cement, storage of cement.				5L + 3T
Module 2	**Aggregates**: Classification, Grading, alkali-aggregate reaction, deleterious substances in aggregates, physical properties, testing of aggregates- fineness modulus, bulking, specific gravity, sieve analysis, flakiness & elongation index. Quality of Water for mixing and curing - use of sea water for mixing concrete.				3L + 1T
Module 3:	**Properties of fresh concrete**: Workability, factors affecting workability, segregation and bleeding, tests on workability- slump test, compacting factor test, vee-bee test, flow table test.				3L + 1T
Module 4:	**Properties of Hardened concrete**: Tensile & compressive strength, flexural strength, stress-strain characteristics, modulus of elasticity, poisson's ratio, Creep, shrinkage, permeability of concrete, micro cracking of concrete.				3L + 1T
Module 5:	**Strength of concrete**: curing methods, water-cement ratio. gel-space ratio, maturity of concrete,				3L + 1T
Module 6	**Admixtures**: types, uses, superplasticizers, plasticizers, Bonding admixtures.				2L + 1T
Module 7	**Mix Design** – Objective, factors influencing mix proportion - Mix design by I.S. 10262-2019. (with & without admixture)				3L + 1T
Module 8	**Non-destructive test**: Rebound hammer and Ultra-sonic pulse velocity testing methods. Quality control - Sampling and testing, Acceptance criteria.				3L + 1T
Module 9	**Special Concrete** – Ferrocement - Fibre reinforced concrete - Polymer concrete - Sulphur Concrete - Self compacting concrete. Ready mix concrete, Batching plant.				4L + 1T
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**	
	1	Concrete Technology (Theory & Practice)	Shetty, M.S.	S. Chand and Co.	
	2	Concrete Technology	Gambhir, M.L.	Tata McGraw Hill	
	3	Concrete Technology	A. M. Nevillie and J.J. Brooks	Pearson Education India Ltd.	
	4	Properties of Concrete	A.M.Neville	Pearson India	

CE(HS)401	**Civil Engineering – Societal and Global Impact**	2L + 0T	2 Credits
Course Outcome	On completion of the course, the students will be able to: **1.** The impact which Civil Engineering projects have on the Society at large and on the global arena and using resources efficiently and effectively. **2.** The extent of Infrastructure, its requirements for energy and how they are met: past, present and future **3.** The Sustainability of the Environment, including its Aesthetics, **4.** The potentials of Civil Engineering for Employment creation and its Contribution to the GDP **5.** The Built Environment and factors impacting the Quality of Life **6.** The precautions to be taken to ensure that the above-mentioned impacts are not adverse but beneficial. **7.** Applying professional and responsible judgement and take a leadership role;		

Prerequisite		
Module 1	**Introduction** to Course and Overview; Understanding the past to look into the future: Preindustrial revolution days, Agricultural revolution, first and second industrial revolutions, IT revolution; Recent major Civil Engineering breakthroughs and innovations; Present day world and future projections, Ecosystems in Society and in Nature; the steady erosion in Sustainability; Global warming, its impact and possible causes; Evaluating future requirements for various resources; GIS and applications for monitoring systems; Human Development Index and Ecological Footprint of India Vs other countries and analysis;	3L
Module 2	**Understanding the importance of Civil Engineering** in shaping and impacting the world; The ancient and modern Marvels and Wonders in the field of Civil Engineering; Future Vision for Civil Engineering	3L
Module 3:	**Infrastructure** - Habitats, Megacities, Smart Cities, futuristic visions; Transportation (Roads, Railways & Metros, Airports, Seaports, River ways, Sea canals, Tunnels (below ground,under water); Futuristic systems (ex, Hyper Loop)); Energy generation (Hydro, Solar (Photovoltaic, Solar Chimney), Wind, Wave, Tidal, Geothermal, Thermal energy); Water provisioning; Telecommunication needs (towers, above-ground and underground cabling); Awareness of various Codes & Standards governing Infrastructure development; Innovations and methodologies for ensuring Sustainability;	8L
Module 4:	**Environment**-Traditional & futuristic methods; Solid waste management, Water purification, Wastewater treatment & Recycling, Hazardous waste treatment; Flood control (Dams, Canals, River interlinking), Multi-purpose water projects, Atmospheric pollution; Global warming phenomena and Pollution Mitigation measures, Stationarity and non-stationarity; Environmental Metrics & Monitoring; Other Sustainability measures; Innovations and methodologies for ensuring Sustainability.	7L
Module 5:	**Built environment**–Facilities management, Climate control; Energy efficient built environments and LEED ratings, Recycling, Temperature/ Sound control in built environment, Security systems; Intelligent/ Smart Buildings; Aesthetics of built environment, Role of Urban Arts Commissions; Conservation, Repairs & Rehabilitation of Structures & Heritage structures; Innovations and methodologies for ensuring Sustainability	5L
Module 6	**Civil Engineering Projects** – Environmental Impact Analysis procedures; Waste (materials, manpower, equipment) avoidance/ Efficiency increase; Advanced construction techniques for better sustainability; Techniques for reduction of Green House Gas emissions in various aspects of Civil Engineering Projects; New Project Management paradigms & Systems (Ex. Lean Construction), contribution of Civil Engineering to GDP, Contribution to employment(projects, facilities management), Quality of products, Health & Safety aspects for stakeholders; Innovations and methodologies for ensuring Sustainability during Project development	4L

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Global Challenges and the Role of Civil Engineering. Chapter 3 in: Fischinger M. (eds) Performance-Based Seismic Engineering: Vision for an Earthquake Resilient Society. Geotechnical, Geological and Earthquake Engineering, Vol. 32.	Žiga Turk (2014)	Springer
	2	Engineering impacting Social, Economical and Working Environment	Brito, Ciampi, Vasconcelos, Amarol, Barros (2013)	120th ASEE Annual Conference and Exposition

CE(MC)401	**Management – I (Organizational Behaviour)**	2L + 0T	2 Credits
Module 1	Introduction to Organizational Behaviour-Concept, Importance, Challenges and Opportunities Personality-Meaning of Personality, Personality Determinants and Traits, Psychoanalytic Theory, Argyris Immaturity to Maturity Continuum Impact on organization. Attitude-Concept, Components, Cognitive Dissonance Theory, Attitude Surveys.		5L
Module 2	Perception- Concept, Nature and Importance, Process of Perception, Factors influencing perception, Perceptual Selectivity, Shortcuts to Judge Others: Halo		6L

	Effect, Stereotyping, Projection and Contrast Effects, Impact on Organization. Motivation-Definition, Theories of Motivation-Maslow's Hierarchy of Needs Theory, McGregor's Theory X&Y, Herzberg's Motivation-Hygiene Theory, Alderfer's ERG Theory, McClelland's Theory of Needs, Vroom's Expectancy Theory.	
Module 3:	Leadership-Concept, Leadership Styles, Theories-Behavioural Theory: Ohio Studies, Michigan Studies, Blake & Mouton Managerial Grid; Contingency Theory: Fielder Theory. Group Behaviour: Definition, Characteristics of Group, Types of Groups: Formal & Informal; Stages of Group Development, Group Decision making, Group Decision Making Vs Individual Decision Making.	8L
Module 4:	Organizational Design-Various organizational structures and their pros and cons. Concepts of organizational climate and culture, Organizational Politics-Concept, Factors influencing degree of Politics Conflict management- Concept, Sources of conflict, Stages of conflict process, Conflict resolution techniques, Tools-Johari Window to analyse and reduce interpersonal conflict, Impact on organization.	5L

Reference	**Sl.**	**Book Name**	**Author**
	1	Organization Behaviour	Stephen Robbins
	2	Organization Behaviour	Luthans
	3	Organization Behaviour	L.M. Prasad
	4	Organization Behaviour : Text, Cases &Games	K. Aswathappa

CE(ES)491	**Fluid Mechanics Laboratory**	2P	1 Credits
Course Outcome	On completion of the course, the students will be able to: **1.** Calibrate the notch and orifice meter. **2.** Evaluate the performance of pump and turbine. **3.** Determine the various hydraulic coefficients. **4.** Determine the minor losses through pipes. **5.** Measure the water surface profile due to formation of hydraulic jump. **6.** Measure the water surface profile for flow over Broad crested weir.		
Prerequisite	Introduction to Fluid Mechanics CE(ES)401		
Experiment 1	Calibration of Notches		
Experiment 2	Calibration of Orifice meter		
Experiment 3	Determination of Hydraulic Coefficient of an Orifice		
Experiment 4	Performance Test on Centrifugal Pump		
Experiment 5	Performance Test on Reciprocating Pump		
Experiment 6	Determination of Minor Losses in Pipes due to Sudden Enlargement and Sudden Contraction		
Experiment 7	Performance Test on Pelton Wheel Turbine		
Experiment 8	Measurement of water surface profile for flow over Broad crested weir		
Experiment 9	Measurement of water surface profile for a hydraulic jump		

CE(ES)492	**Solid Mechanics Laboratory**	2P	1 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Demonstrate the method and findings of tension and compression tests on ductile and brittle materials. **2.** Explain the method of bending tests on mild steel beam and concrete beam. **3.** Demonstrate the method and findings of Torsion test on mild steel circular bar and concrete beam. **4.** Illustrate the concept of hardness and explain the procedure and findings of Brinnel and Rockwell tests. **5.** Demonstrate the concept and procedure of calculation of spring constant and elaborate its use in Civil Engineering. **6.** Demonstrate the method and findings of Izod and Charpy impact tests. **7.** Understand the concepts of fatigue test.		
Prerequisite	Introduction to Solid Mechanics (CE(ES)402)		

Experiment 1	Tension test on Structural Materials: Mild Steel and Tor steel (HYSD bars)
Experiment 2	Compression Test on Structural Materials: Timber, bricks and concrete cubes
Experiment 3	Bending Test on Mild Steel
Experiment 4	Torsion Test on Mild Steel Circular Bar
Experiment 5	Hardness Tests on Ferrous and Non-Ferrous Metals: Brinnel and Rockwell Tests
Experiment 6	Test on closely coiled helical spring
Experiment 7	Impact Test: Izod and Charpy
Experiment 8	Demonstration of Fatigue Test

CE(ES)493	**Engineering Geology Laboratory**	2P	1 Credits
Course Outcome	Upon completion of the course, the students will be able to: **1.** Define and state the role of engineering geology in civil engineering **2.** Understand origin of rocks and geologic structures **3.** Apply different tools to identify rocks and minerals in hand specimen and under microscope **4.** Analyze the geological structures through drawing the cross sections from the geological maps **5.** Evaluate the results obtained from different geological experiments **6.** Investigate the natural hazards/disasters that are caused by the geological reasons		
Prerequisite	Knowledge of basic physics and chemistry		
Experiment 1	Identification of minerals in hand specimen		
Experiment 2	Identification of igneous rocks in hand specimen		
Experiment 3	Identification of sedimentary rocks in hand specimen		
Experiment 4	Identification of metamorphic rocks in hand specimen		
Experiment 5	Study of crystals with the help of crystal models		
Experiment 6	Study of geologic structures with the help of models		
Experiment 7	Interpretation of geological maps: horizontal, vertical, uniclinal, folded and faulted structures		
Experiment 8	Microscopic study of rocks and minerals		

CE(PC)493	**Surveying & Geomatics Laboratory**	2P	1 Credits
Course Outcome	Upon completion of the course, the students will be able to: **1.** State the interdependency and advancement of different surveying methods **2.** Comprehend the working principles of different surveying and geomatics instruments and experiments **3.** Execute the different methods of surveying and geomatics to measure the features of interest **4.** Examine the results obtained from the surveying and geomatics experiments **5.** Critically appraise the different techniques of surveying and geomatics in measuring and assessing the features of interest **6.** Design and construct solutions for real world problems related to surveying and geomatics.		
Prerequisite	Surveying & Geomatics [CE(PC)403]		
Experiment 1	Traverse survey by Prismatic Compass: Procedure; Computation and checks on closed traverse; Preparation of field book; Plotting the traverse; Sources of errors.		
Experiment 2	Theodolite Survey: Closed traverse by transit theodolite, Preparation of field book		
Experiment 3	Differential Levelling using Dumpy level: Collimation and Rise and Fall methods, Field book preparation		
Experiment 4	Total Station Survey: Traversing and Levelling		
Experiment 5	Visual Image Interpretation		
Experiment 6	Satellite Image Pre-processing		
Experiment 7	Digital Image Classification and Accuracy Assessment		
Experiment 8	Stereoscopic fusion of aerial photographs using mirror stereoscope		

CE(PC)494	Concrete Technology Laboratory	2P	1 Credits
Course Outcome	On completion of the course, the students will be able to: **1.** Demonstrate the method and findings of tension and compression tests on concrete. **2.** Understand the concepts of different test on hardened concrete. **3.** Calculate the specific gravity of concrete ingredients. **4.** Find out the mix proportion of high grade of concrete. **5.** Measure the workability of concrete mix. **6.** Know about the quality of concrete. **7.** Understand the different properties of cement.		
Prerequisite	Concrete Technology CE(PC)404		
Test on Fine aggregates	Bulking, Specific gravity, Bulk Density, Percentage voids, Fineness Modulus. Grading curve.		
Test on Coarse aggregates	Specific gravity, Bulk Density, Percentage voids, Fineness Modulus. Grading curve.		
Test on Cement	Normal consistency, fineness, Initial setting and final setting time of cement. Specific gravity, soundness and Compressive strength of Cement.		
Test on Fresh Concrete	Concrete mix design, Various workability tests – slump, compacting factor, vee-bee test.		
Test on Hardened Concrete	Spilt-tensile strength test, Flexure test, NDT Tests (Rebound hammer and Ultra-sonic pulse velocity), Poission ratio.		

Semester V [Third year]

CE(PC)501	Design of RC Structures	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Understand material properties and design methodologies for reinforced concrete structures. **2.** Assess different type of loads and prepare layout for reinforced concrete structures. **3.** Identify and apply the applicable industrial design codes relevant to the design of reinforced concrete members. **4.** Analyse and design various structural elements of reinforced concrete building like beam, slab, column, footing, and staircase. **5.** Assessment of serviceability criteria for reinforced concrete beam and slab. **6.** Prepare structural drawings and detailing and produce design calculations and drawing in appropriate professional format.		
Prerequisite	Introduction to Solid Mechanics (CE(ES)402), Concrete Technology (CE(PC)404).		
Module 1:	**Introduction:** Principles of design of reinforced concrete members - Working stress and Limit State method of design		1L
Module 2:	**Working stress method of design:** Basic concepts and IS code provisions (IS: 456 2000)for design against bending moment and shear forces - Balanced, under reinforced and overreinforced beam/ slab sections; design of singly and doubly reinforced sections		2L+2T
Module 3:	**Limit state method of design**: Basic concepts and IS code provisions (IS: 456 2000) for design against bending moment and shear forces; concepts of bond stress and development length; Use of 'design aids for reinforced concrete' (SP:16).		5L+2T
Module 4:	**Beam Design by LSM:** Analysis, design and detailing of singly reinforced rectangular, 'T', 'L' and doubly reinforced beam sections by limit state method.		3L+2T
Module 5:	**Slab Design by LSM :** Design and detailing of one-way and two-way slab panels as per IS code provisions		2L+1T
Module 6:	**Continuous slab and beam design by LSM:** Design and detailing of continuous beams and slabs as per IS code provisions		2L+1T
Module 7:	**Design of Staircases by LSM**: Types; Design and detailing of reinforced concrete doglegged staircase		3L+1T
Module 8	**Design of Columns by LSM**: Design and detailing of reinforced concrete short columns of rectangular and circular crosssections under axial load. Design of short columns subjected to axial load with moments (uniaxial and biaxial bending) – using SP 16.		4L+1T
Module 9	**Design of Foundation by LSM:** Design and detailing of reinforced concrete isolated square and rectangular isolated and combined footing for columns as per IS code provisions by limit state method Design and detailing of Pile foundation as per IS code provisions.		6L+2T
IS Codes	**1**	IS: 456 - 2000	
	2	IS 875 – I (1987), II (1987), -III (2015), -IV(1987), V (1987)	
	3	SP: 16 Design Aid to IS 456	

Reference	Sl.	Book Name	Author	Publishing House
	1	Reinforced Concrete Design	Pillai and Menon	TMH
	2	Reinforced Concrete Design	Krishna Raju & Pranesh	New Age
	3	R.C.C. Design	B.C. Punmia	Laxmi Publication
	4	Reinforced concrete structures	N. Subramanian	OXFORD University Press
	5	Limit State Design of Reinforced Concrete	P. C. Varghese	PHI
	6	Reinforced concrete	S.N. Sinha	TMH

CE(PC)502	**Engineering Hydrology**	3L + 0T	3 Credits
Course Outcome	On completion of the course, the students will be able to: **10.** study the source, occurrence, movement and distribution of water which is a prime resource for development of a nation. **11.** learn about the functioning of reservoirs and estimation of storage capacities. **12.** learn about flood hazards, estimation of design floods for various structures and methods of estimating effects of passage of floods through rivers and reservoirs. **13.** know the basic principles of measurement of flow in rivers.		
Prerequisite	Introduction to Civil Engineering CE(HS)302, CE(ES)401_Fluid Mechanics, Chemistry BS-CH101, Physics BS-PH101.		
Module 1	Hydrology: Hydrologic Cycle, Global Water Budget, India's Water Budget.		1L
Module 2	Catchment: Definition & Descriptions, Various Types of Catchment, Factors Characterizing a Catchment, Delineation of Catchment Boundary.		2L
Module 3:	Measurement of Precipitation: Precipitation, Description and Functioning of Various Types of Rain gauges, Rain gauge Network- Codal Provisions, Optimum Number of Raingauge Stations.		2L
Module 4:	Processing of Rainfall Data: Normal Rainfall, Estimation of Missing Rainfall Data, Test for Consistency of Record; Mass Curve of Rainfall, Hyetograph, Point Rainfall; Mean Precipitation over an Area– Arithmetic Mean, Thiessen Polygon and Isohyetal Method.		4L
Module 5:	Losses from Precipitation: Evaporation – Evaporation Process, Factors affecting Evaporation, Measurement of Evaporation– Description and Functioning of Pan Evaporimeter, Pan Coefficient, Evapotranspiration: AET, PET, Measurement of ET, Estimation of ET–Blaney Criddle Formulae; Infiltration– Process, Factors Affecting Infiltration, Infiltration Rate and Infiltration Capacity, Measurement of Infiltration, Infiltration Equations, Infiltration Indices.		6L
Module 6	Streamflow Measurement: Importance, Direct and Indirect Methods, Measurement of Stage– Various Gauges and Recorders, Measurement of Velocity–Current Meters, their Functioning and Calibration; Velocity Distribution, Floats; Streamflow Computation– Area-Velocity Method, Moving Boat Method, Dilution Technique, Electromagnetic Method, Ultrasonic Method; Indirect Methods– Flow Measuring Structures, Slope Area Method; Stage-Discharge Relation, Permanent Control, Stage for Zero Discharge, Shifting Control– Backwater Effect, Unsteady Flow Effect, Extension of the Rating Curve.		12L
Module 7	Runoff: Description of the Process, Components of Runoff, Factors Affecting Runoff, Characteristics of Streams, Rainfall Runoff Relationships. Hydrographs: Types, Base Flow Separation, Effective Rainfall.		2L
Module 8	Unit Hydrograph– Definition, Assumptions, Applications– Derivation of Unit Hydrograph, Distribution Graph, Unit Hydrograph of Different Durations– Method of Superposition and S-Curve.		4L
Module 9	Floods: Concept of flood as a natural hazard; Estimation of flood discharge in a river – rational method, empirical formulae, unit hydrograph method; flood frequency studies – return period.		2L
Module 10	Flood Routing: Concept of flood routing in channels and through a reservoir, basic routing equations; reservoir routing – Modified Pul's method; channel routing – Muskingum method.		5L

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Engineering Hydrology (4th Ed.	K. Subramanya	McGraw Hill Education (India) Private Limited, New Delhi, 2013.
	2	Engineering Hydrology	R. Srivastava and A. Jain	McGraw Hill Education (India) Private Limited, New Delhi, 2017.
	3	Applied Hydrology	V. T. Chow, D. Maidment, L. Mays	Tata McGraw Hill Edition, New Delhi, 2010.

	4	Hydrology	M. M. Das, M. Das Saikia	PHI Learning Private Limited, New Delhi, 2009.

CE(PC)503	**Structural Analysis – I**	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Distinguish between stable and unstable and statically determinate and indeterminate structures. **2.** Apply equations of equilibrium to structures and compute the reactions. **3.** Calculate the internal forces in cable and arch type structures. **4.** Evaluate and draw the influence lines for reactions, shears and bending moments in beams due to moving loads. **5.** Use approximate methods for analysis of statically indeterminate structures. **6.** Calculate the deflections of truss structures and beams.		
Prerequisite	Introduction to Solid Mechanics (CE(ES)402)		
Module 1	**Basics of Structural Analysis**: Concept of static and kinematic indeterminacy, Determination of degree of indeterminacy for different types of structures. Theorem of minimum potential energy, law of conservation energy, principle of virtual work, the first and second theorems of Castigilano, Betti's law, Clark Maxwell's theorem of reciprocal deflection		3L+1T
Module 2	**Analysis of Determinate Structures:** Portal Frames, Three hinged arches, Cables		3L+2T
Module 3	**Deflection of Determinate Structures**: Energy methods. Unit Load method for beams, Deflection of trusses and Simple Portal Frames.		3L+2T
Module 4	**Influence Line Diagram:** Statically determinate beams and trusses under series of concentrated and uniformly distributed rolling loads, criteria for maximum and absolute maximum moments and shear.		6L+3T
Module 5	**Analysis of Statically Indeterminate Beams**: Theorem of three moments, Energy methods, Force method (Method of consistent deformation) [For analysis of propped cantilever, fixed beams and continuous beams (maximum two degree of indeterminacy) for simple loading case], Analysis of two hinged arch.		8L+4T
Module 6	**Influence Line Diagram for Indeterminate Structures:** Muller – Breslau principle.		3L+2T

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Structural Analysis (Vol I & Vol II)	S S Bhavikatti	Vikas Publishing House Pvt. Ltd
	2	Structural Analysis	Ramammurtham	
	3	Strength of Materials and Theory of Structures (Vol I & Vol II)	Punmia, Jain, Jain	Laxmi Publication
	4	Structural Analysis	R.C. Hibbeler	Prentice Hall
	5	Theory of Structures	Timoshenko and Young	McGrawHill
	6	Structural Analysis	Pandit and Gupta	TMH

CE(PC)504	**Soil Mechanics – II**	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Assess the compaction and consolidation characteristics of soil for solving geotechnical problems. **2.** Calculate earth pressure on rigid retaining walls on the basis of classical earth pressure theories. **3.** Analyze and design rigid retaining walls (cantilever types) from geotechnical engineering consideration. **4.** Evaluate the bearing capacity of shallow foundation by applying established theory. **5.** Estimate settlement in soils by different methods. **6.** Compute safety of dams and embankments on the basis of various methods of slope stability analysis.		
Prerequisite	Soil Mechanics – I (CE(PC)401)		
Module 1	**Consolidation of Soil** Terzaghi's theory of one dimensional consolidation, Compressibility characteristics of soils, Compression index, Coefficient of compressibility and volume change, Coefficient of consolidation, Degree and rate of consolidation, Time factor, Settlement computation, Consolidometer and laboratory one dimensional consolidation test as per latest IS Code, Determination of consolidation parameters.		5L+3T

Module 2	**Compaction of Soil** Principles of compaction, Standard and modified proctor compaction test, Field compaction methods, Field compaction control, Factors affecting compaction, Effect of compaction on soil properties.	3L+1T
Module 3	**Earth Pressure Theories** Plastic equilibrium of soil, Earth pressure at rest, Active and passive earth pressures, Rankine's and Coulomb's earth pressure theories, Different types of backfill, Wedge method of analysis. Analytical and graphical methods for determination of earth pressure against various earth retaining structures. **Stability of retaining walls:** Cantilever retaining wall.	7L+3T
Module 4	**Bearing capacity of shallow foundations** Bearing capacity, Definition, Factors affecting bearing capacity, Modes of failures, Methods of determining bearing capacity of soils. Terzaghi's bearing capacity theory, Effect of depth of embedment, Eccentricity of load, Foundation shape on bearing capacity, Effect of 11 water table and eccentric loads. Isolated footings with combined action of loads and moments, Bearing capacity as per IS: 6403.	7L+4T
Module 5	**Settlement** Allowable bearing pressure and settlement analysis (as per IS: 8009), Immediate and consolidation settlements, Rigidity and depth factor corrections, Settlement values as per IS: 1904 recommendations.	2L+1T
Module 6	**Stability of slopes** Types of failure, Analysis of finite and infinite slopes, Swedish and friction circle method, Ordinary method of slices, Factor of safety, Taylor's stability number, Bishop's simplified method of stability analysis.	3L+2T

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Textbook of Soil Mechanics and Foundation Engineering (Geotechnical Engineering Series)	V.N.S. Murthy	CBS Publishers
	2	Soil Mechanics and Foundations	Punmia, B.C. and Jain A. K	Laxmi Publications (P) Ltd
	3	Basic and Applied Soil Mechanics	Gopal Ranjan & A.S.R. Rao	New Age International Pvt.Ltd, Publishers
	4	Principles of Geotechnical Engineering	B.M. Das	Thomson Brooks / Cole

CE(PC)505	**Environmental Engineering – II**	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: 1. Define the basic concepts and terminologies of waste water engineering and hazardous waste management 2. Describe different home plumbing systems for water supply and wastewater disposal 3. Apply the methods of quantifying sanitary sewage and storm sewage 4. Solve different mathematical problems regarding different components of sewerage system 5. Compare between different wastewater samples based on their physical, chemical and biological characteristics 6. Design different unit processes and operations involved in wastewater treatment		
Prerequisite	Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Engineering Mechanics, Fluid Mechanics and Hydraulics; Environmental Engineering – I (CE(PC)402)		
Module 1	**Sewage and Drainage** Definition of Common Terms: Sewage or Sanitary Sewage, Drainage or Storm Sewage, Sullage, Black Water, Grey Water Sewerage Systems: Separate system, Combined System, Partially Separate System; applicability, advantages and disadvantages		1L+1T
Module 2	**Sewage and Drainage Quantity** Quantity estimation for sanitary sewage; Quantity estimation for storm sewage		3L+1T
Module 3	**Conveyance of Sewage** Sewers: Shapes; Design parameters; Operation and maintenance of sewers; Sewer appurtenances Hydraulic Design of Sewers: Partial flow diagrams and Nomograms		4L+2T
Module 4	**Wastewater Characteristics** Physical, chemical and biological characteristics of municipal and domestic sewage; Effluent discharge standards		4L+2T

Module 5	**Wastewater Treatment** Primary, secondary and tertiary treatment of wastewater; aerobic an anaerobic treatment options Primary and Secondary Treatment of Domestic Wastewater: Typical Flow Chart of STP; Screen and Bar Racks; Grit Chamber; Primary and Secondary Sedimentation Tank; Activated Sludge Process; Trickling Filter	8L+4T
Module 6	**Sludge Handling and Disposal** Sludge Thickening; Sludge Digestion; Sludge Drying Bed	3L+1T
Module 7	**Building Plumbing** Introduction to various types of home plumbing systems for water supply and waste water disposal; high rise building plumbing; Pressure reducing valves; Break pressure tanks; Storage tanks; Building drainage for high rise buildings; various kinds of fixtures and fittings used	3L+1T
Module 8	**Hazardous waste** Types and nature of hazardous waste as per the HW Schedules of regulating authorities	3L+1T

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Environmental Engineering. Volume-1 and Volume-2	Garg, S.K.	Khanna Publishers
	2	Environmental Engineering	Peavy, H.S, Rowe, D.R, Tchobanoglous, G	Tata McGraw Hill Indian Edition
	3	Introduction to Environmental Engineering and Science	Masters, G.M., Ela, W.P.	Prentice Hall / Pearson
	4	Manual on Sewerage and Sewage Treatment	CPHEEO	Govt. of India
	5	Manual on Municipal Solid Waste Management.	CPHEEO	Govt. of India
	6	Hazardous and other waste (Management and Transboundary Movement) Rules, 2016	MoEF	Govt. of India

CE(PC)506	**Transportation Engineering**	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Understand the knowledge of planning, design and the fundamental properties of highway materials in highway engineering. **2.** Apply the knowledge of geometric design and draw appropriate conclusion. **3.** Interpret the concept of different methods in design, construction of the pavement. **4.** Interpret traffic parameters by applying the knowledge in traffic planning and intersection design.		
Prerequisite	Class-XII level knowledge of Physics, Mathematics; Undergraduate level knowledge of Engineering Mechanics, Strength of Materials, Soil Mechanics		
Module 1	**Introduction to Highway Engineering** Scope of Highway Engineering; Jayakar Committee Report: Recommendations – CRF, IRC, CRRI; Scope of Motor Vehicle Act; Recommendations of Nagpur Road conference; Road Classification as per third 20 years road development plan (1981-2001); Basic types of Road Patterns and its scope of application		2L+1T
Module 2	**Highway alignment** Factors controlling Highway Alignment; Engineering Surveys for Highway Alignment.		1L+1T
Module 3	**Geometric Design** Cross-sectional elements of highway; Design Parameters (as per IRC) – Vehicle dimensions, Carriageway width, Design speed, Frictional coefficients (Lateral and Longitudinal) etc; Design Principles of Horizontal Alignment: Camber, Sight Distance (PIEV theory, SSD, OSD, ISD); Horizontal Curves – [Radius, Super elevation, Extra widening, Set back distance, Transition curve]; Design Principles of Vertical Alignment: Gradients; Grade Compensation; Vertical Curves – Summit Curve, Valley curve.		8L+4T
Module 4	**Traffic Engineering** Traffic studies: Fundamental parameters of Traffic Flow (speed, flow, density, capacity) and their basic relations; Basics of Spot Speed Studies- Speed and Delay study- O & D study; Intersections and Channelization: At Grade and Grade Separated intersections; Conflict points; Salient features of Rotary; Traffic Signs; Signal Design – Basic concepts of IRC design method, 2 phase signal design by Webster method.		7L+3T

Module 5	**Pavement Design** Pavement materials: Bitumen, Aggregate, Subgrade soil; Types of Pavement: Flexible and Rigid pavements and their typical cross-sections; Design parameters: Wheel Load, ESWL, Tyre Pressure, CBR, Resilient Modulus & Poisson's Ratio of various layers, Subgrade Modulus etc. Design of Flexible Pavement using IRC 37:2018 Design of Rigid Pavement: Wheel Stresses, Frictional Stresses and Warping Stresses; Expansion, Contraction and Construction Joints; Design of Rigid Pavement thickness, Dowel Bar and Tie Bar. Distresses in Pavements	8L+5T
Module 6	**Sustainability** Scope of adoption of sustainable construction techniques by using recyclable hazardous materials- fly ash, plastics, recyclable construction materials.	1L+1T

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Traffic Engineering and Transport Planning	Kadiyali L.R	Khanna Publishers
	2	Highway Engineering	Khanna, S.K. and C.E.G. Justo	Nem Chand and Bros
	3	Transportation Engineering – An Introduction	Jotin Khisty C. and B. Kent Lall	Prentice Hall of India Pvt. Ltd
	4	Principles of Transportation and Highway Engineering	Rao G.V.	Tata McGraw-Hill Publishing Company Ltd
	5	Specifications for Road and Bridge Works, Fourth Edition	Indian Roads Congress	Ministry of Road Transport and Highways

CE(PC)591	**RC Design Sessional**	2P	1 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Understand material properties and design methodologies for reinforced concrete structures. **2.** Assess different type of loads and prepare layout for reinforced concrete structures. **3.** Identify and apply the applicable industrial design codes relevant to the design of reinforced concrete members. **4.** Analyse and design various structural elements of reinforced concrete building like beam, slab, column, footing, and staircase. **5.** Assessment of serviceability criteria for reinforced concrete beam and slab. **6.** Prepare structural drawings and detailing and produce design calculations and drawing in appropriate professional format.		
Prerequisite	Design of RC Structures (CE(PC)501)		
	Design of a small RCC framed building using Limit State method of design including preparation of necessary working drawing and report in accordance with CE(PC)501		

CE(PC)594	**Soil Mechanics Laboratory**	2P	1 Credits
Course Outcome	After going through this course, the students will be able to: 1. Identify different types of soil by visual inspection. 2. Determine natural moisture content and specific gravity of various types of soil. 3. Estimate in-situ density by core cutter method and sand replacement method. 4. Analyze grain size distribution and Atterberg limits for soil. 5. Perform laboratory tests to determine permeability and compaction characteristics of soil. 6. Determine shear strength parameters of soil by unconfined compression test and vane shear test. 7. Determine shear strength parameters of soil by direct shear test. 8. Perform triaxial test to determine shear strength parameters of soil. 9. Determine California Bearing Ratio (CBR) of soil. 10. Prepare technical laboratory report		
Prerequisite	Soil Mechanics – I (CE(PC)401) and Soil Mechanics – II (CE(PC)504)		
Experiment 1	Field identification of different types of soil as per Indian Standards [collection of field samples and identifications without laboratory testing].		
Experiment 2	Determination of natural moisture content.		
Experiment 3	Determination of specific gravity of cohesionless and cohesive soils.		
Experiment 4	Determination of in-situ density by core cutter method and sand replacement method.		
Experiment 5	Determination of grain size distribution by sieve and hydrometer analysis.		
Experiment 6	Determination of Atterberg limits (liquid limit, plastic limit and shrinkage limit).		
Experiment 7	Determination of co-efficient of permeability by constant and variable head permeability tests.		
Experiment 8	Determination of compaction characteristics of soil by standard proctor compaction test.		

Experiment 9	Determination of unconfined compressive strength of soil by unconfined compression test.
Experiment 10	Determination of shear strength parameters of soil by direct shear test.
Experiment 11	Determination of undrained shear strength of soil by vane shear test.
Experiment 12	Determination of shear strength parameters of soil by unconsolidated undrained triaxial test.
Experiment 13	Determination of California Bearing Ratio (CBR) of soil.
Experiment 14	Determination of relative density of soil.
Experiment 15	Standard Penetration Test.
Reference	**1.** Soil Mechanics Laboratory Manual by Braja Mohan Das (Oxford university press). **2.** SP: 36 (Part - I and Part - II)

CE(PC)595	**Environmental Engineering Laboratory**	2P	1 Credits
Course Outcome	On completion of the course the students will be able to: **1.** Experiment various physical characteristics for a given sample of water and wastewater **2.** Determine various chemical characteristics for a given sample of water and wastewater **3.** Examine the bacteriological characteristics for a given sample of water and wastewater **4.** Examine the suitability of a few treatment options for a given sample of water and wastewater **5.** Compare the determined quality parameters with standards to decide on the suitability of use for the tested water and disposal of tested wastewater		
Prerequisite	Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Environmental Engineering, Biology for Engineers, Chemistry Laboratory, Physics Laboratory		
Experiment 1	Determination of turbidity for a given sample of water		
Experiment 2	Determination of electrical conductivity for a given sample of water		
Experiment 3	Determination of Total Solids, Suspended Solids, Dissolved Solids and Volatile Solids in a given sample of water		
Experiment 4	Determination of pH for a given sample of water		
Experiment 5	Determination of carbonate, bi-carbonate and hydroxide alkalinity for a given sample of water		
Experiment 6	Determination of acidity for a given sample of water		
Experiment 7	Determination of hardness for a given sample of water		
Experiment 8	Determination of concentration of Iron in a given sample of water		
Experiment 9	Determination of concentration of Chlorides in a given sample of water		
Experiment 10	Determination of the Optimum Alum Dose for a given sample of water through Jar Test		
Experiment 11	Determination of the Chlorine Demand and Break-Point Chlorination for a given sample of water		
Experiment 12	Determination of amount of Dissolved Oxygen (DO) in a given sample of water		
Experiment 13	Determination of the Biochemical Oxygen Demand (BOD) for a given sample of wastewater		
Experiment 14	Determination of the Chemical Oxygen Demand (COD) for a given sample of wastewater		
Experiment 15	Determination of Colliform Bacteria: presumptive test, Confirmative test and Determination of MPN		
Reference	**1.** Garg, S.K. *Environmental Engineering*. Volume-1 and Volume-2. Khanna Publishers **2.** Peavy, H.S, Rowe, D.R, Tchobanoglous, G. *Environmental Engineering*. McGraw Hill International Edition / Tata McGraw Hill Indian Edition **3.** Sawyer, C.N., McCarty, P.L., Parkin, G.F. *Chemistry for Environmental Engineering and Science*. McGraw Hill International Edition / Tata McGraw Hill Indian Edition **4.** IS: 3025 (Different Parts), "METIHODS OF SAMPLING AND TEST (PIIYSICAL AND CHEMICAL) FOR WATER AND WASTE WATER". **5.** APHA Standard Methods for the Examination of Water and Wastewater. **6.** IS: 10500 – 2012, "DRINKING WATER SPECIFICATION (SECOND REVISION)".		

CE(PC)596	**Transportation Engineering Laboratory**	2P	1 Credits
Prerequisite	Transportation Engineering (CE(PC)506)		
Introduction	Introduction on pavement construction materials		
Experiment 1	Shape test of aggregate		
Experiment 2	Crushing Strength Test of aggregate		
Experiment 3	Impact test of aggregate		
Experiment 4	Los Angeles Abrasion test of aggregate		
Experiment 5	Specific Gravity and Water Absorption test of aggregate		
Experiment 6	Specific Gravity test		
Experiment 7	Penetration test		
Experiment 8	Static or Kinematic viscosity		

Experiment 9	Softening point test
Experiment 10	Flash and Fire Point test
Experiment 11	Ductility test
Experiment 12	CBR value of sub-grade (Soaked and unsoaked)
Experiment 13	Marshall Stability test
Demonstration	Demonstration on Stripping value and Loss on heating tests of bitumen, Benkelman Beam and Bump Integrator test.

CE(PC)597	**Computer Applications in Civil Engineering**	2P	1 Credits
Course Outcome	On successful completion of this course, student should be able to: **7.** Use the computer as a problem-solving tool. **8.** Identify and formulate Civil Engineering problems solvable by computers. **9.** Perform linear algebra and matrix operations and their application to solve Civil Engineering problems **10.** Solve sets of linear equations and determine roots and nonlinear equations **11.** Construct, interpret and solve simple optimization problems **12.** Develop programs for Civil Engineering analysis and design problems. **13.** Use various software used in industries for analysis and design.		
Prerequisite	ES-CS291 Programming for Problem Solving, CE(ES)392 Computer-aided Civil Engineering Drawing.		
Module 1	**Introduction:** Concept of problem-solving using computer, use of programming language and software for problem solving; Identification of various design and analysis problems in different fields of Civil Engineering to be solved using computers; Procedure, formulae and data related to the analysis and design of such problems.		
Module 2	**Use of spreadsheets:** Learning spreadsheets like MS Excel, matrix analysis, use of Goal Seek and Solver, Optimization Tools; Plotting. Applications to problems involving tabular data, CE estimation, surveying, and design problems.		
Module 3	**Programming Languages:** Learning at least one language: Fortran 2003/2008/2018, C++11/C++14, Python 3, VBA 7.0; Computing platforms like Matlab/Scilab/MathCAD; Solving analysis and design problems in areas like surveying, hydraulics, structural analysis, RCC design, soil mechanics and foundation, transportation, water resources, etc.		
Module 4	**Use of Software:** Familiarity with widely used Civil Engineering software like STAAD Pro, HEC-RAS, HEC-HMS, SWMM, Mx Roads, etc.; Solving at least two such analysis/design problems.		

Semester VI [Third year]

CE(PC)601	**Construction engineering & Management**	2L + 0T	2 Credits
Course Outcome	**On completion of the course, the students will have:** **1.** An idea of how structures are built and projects are developed on the field **2.** An understanding of modern construction practices **3.** A good idea of basic construction dynamics- various stakeholders, project objectives, processes, resources required and project economics **4.** A basic ability to plan, control and monitor construction projects with respect to time and cost **5.** An idea of how to optimise construction projects based on costs **6.** An idea how construction projects are administered with respect to contract structures and issues. **7.** An ability to put forward ideas and understandings to others with effective communication processes		
Module 1	**Planning:** General consideration, Definition of aspect, prospect, roominess, grouping, circulation, Privacy.		2L
Module 2	**Regulation and Bye laws** Bye Laws in respect of side space, Back and front space, Covered areas, height of building etc., Lavatory blocks , ventilation, Requirements for stairs, lifts in public assembly building, offices		4L
Module 3:	**Fire Protection** Fire fighting arrangements in public assembly buildings, planning , offices,		2L

	auditorium	
Module 4:	**Planning &Scheduling of constructions Projects** **Planning by CPM** Preparation of network, Determination of slacks or floats. Critical activities. Critical path. Project duration. **Planning by PERT** Expected mean time, probability of completion of project, Estimation of critical path, problems	6L
Module 5:	**Construction Methods basics** Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods (conventional walls and slabs; conventional framed structure with blockwork walls; Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges.	4L
Module 6	**Construction plants & Equipment** Plants & equipment for earth moving, road constructions, excavators, dozers, scrapers, spreaders, rollers, their uses. **Plants &Equipment for concrete construction** Batching plants, Ready Mix Concrete, concrete mixers, Vibrators etc., quality control.	3L
Module 7	Contracts Management basics Importance of contracts; Types of Contracts, parties to a contract; Common contract clauses (Notice to proceed, rights and duties of various parties, notices to be given, Contract Duration and Price. Performance parameters; Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination. Changes & variations, Dispute Resolution methods.	4L
Module 8	**Management** Professional practice, Definition, Rights and responsibilities of owner, engineer, Contractors, types of contract	3L
Module 9	**Departmental Procedures** Administration, Technical and financial sanction, operation of PWD, Tenders and its notification, EMD and SD, Acceptance of tenders, Arbritation	2L

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	*Building Construction*	Varghese, P.C.	Prentice Hall India,
	2	*National Building Code*	Bureau of Indian Standards	
	3	*Construction Technology*	Chudley, R.	ELBS Publishers
	4	Construction Planning, Methods and Equipment	Peurifoy, R.L.	McGraw Hill
	5	Construction Methods and Management,	Nunnally, S.W.	Prentice Hall
	6	Project Planning with PERT and CPM	Punmia, B.C., Khandelwal, K.K.	Laxmi Publications

CE(PC)602	**Engineering Economics, Estimation & Costing**	2L + 0T	2 Credits
Course Outcome	**On completion of the course, the students will:** **1.** Have an idea of Economics in general, Economics of India particularly for public sector agencies and private sector businesses **2.** Be able to perform and evaluate present worth, future worth and annual worth analyses on one of more economic alternatives. **3.** Be able to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives. **4.** Be able to understand the technical specifications for various works to be performed for a project and how they impact the cost of a structure. **5.** Be able to quantify the worth of a structure by evaluating quantities of constituents, derive their cost rates and build up the overall cost of the structure. **6.** Be able to understand how competitive bidding works and how to submit a competitive bid proposal.		
Module 1	**Basic Principles and Methodology of Economics.** Demand/Supply – elasticity – Government Policies and Application. Theory of the Firm and Market Structure. Basic Macroeconomic Concepts (including GDP/GNP/NI/Disposable Income) and Identities for both closed and open economies.		3L

	Aggregate demand and Supply (IS/LM). Price Indices (WPI/CPI), Interest rates, Direct and Indirect Taxes	
Module 2	**Elements of Business/Managerial Economics and forms of organizations.** Cost & Cost Control –Techniques, Types of Costs, Lifecycle costs, Budgets, Break even Analysis, Capital Budgeting, Application of Linear Programming. Investment Analysis – NPV, ROI, IRR, Payback Period, Depreciation, Time value of money (present and future worth of cash flows). Business Forecasting – Elementary techniques. Statements – Cash flow, Financial. Case Study Method.	3L
Module 3:	**Estimation / Measurements for various items** Introduction to the process of Estimation; Use of relevant Indian Standard Specifications for the same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams, Estimating Earthwork and Foundations, Estimating Concrete and Masonry, Finishes, Interiors, MEP works; BIM and quantity take-offs; adding equipment costs; labour costs; rate analysis; Material survey-Thumb rules for computation of materials requirement for different materials for buildings, percentage breakup of the cost, cost sensitive index, market survey of basic materials. Use of Computers in quantity surveying	9L
Module 4:	**Specifications** Types, requirements and importance, detailed specifications for buildings, roads, minor bridges and industrial structures.	3L
Module 5:	**Rate analysis** Purpose, importance and necessity of the same, factors affecting, task work, daily output from different equipment/ productivity.	3L
Module 6	**Tender-** Preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. general and special conditions, termination of contracts, extra work and Changes, penalty and liquidated charges, Settlement of disputes, R.A. Bill & Final Bill, Payment of advance, insurance, claims, price variation, etc. Preparing Bids- Bid Price buildup: Material, Labour, Equipment costs, Risks, Direct & Indirect Overheads, Profits; Bid conditions, alternative specifications; Alternative Bids. Bid process management	3L
Module 7	**Valuation** Values and cost, gross income, outgoing, net income, scrap value, salvage value, market value, Book Value, sinking fund, capitalised value, Y. P., depreciation, obsolescence, deferred income, freehold and leasehold property, mortgage, rent fixation, valuation table	3L
Module 8	Introduction to Acts pertaining to-Minimum wages, Workman's compensation, Contracts, Arbitration, Easement rights.	2L

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Estimating, Costing Specifications & Valuation	M Chakravarty	
	2	Typical PWD Rate Analysis documents.		
	3	Estimating and Costing in Civil Engineering (Theory & Practice)	Dutta, B.N.	UBS Publishers
	4	Distributors, Estimating and Costing in Civil Engineering: Theory and Practice including Specification and Valuations		UBS Publishers

CE(PC)603	**Water Resources Engineering**	2L + 0T	2 Credits
Course Outcome	On successful completion of this course, student should be able to: 1. Understand the fundamentals of flow in open channels. 2. Understand the concepts of irrigation. 3. Estimate the quantity of water required by different crops in different seasons, and accordingly the irrigation water requirement. 4. Design channels and other irrigation structures required for irrigation, drainage, soil conservation, flood control and other water-management projects. 5. Learn about groundwater resources, aquifers and wells.		
Prerequisite	Introduction to Civil Engineering, Introduction to Fluid Mechanics CE(ES)401		

Module 1	**Open Channel Flow:** Channel Characteristics and parameters, Energy-depth relationships, Specific Energy concept, Critical Flow, Hydraulic Jump, Uniform flow, Efficient sections, Slope profiles, Gradually Varied Flow, Water surface profiles.	8L
Module 2	**Irrigation:** Definition, Necessity, Scope, Benefits of Irrigation; Types, techniques and sources of irrigation; Development of irrigation in India.	3L
Module 3:	**Soil-water-plant Relationship:** Types of crops, cropping seasons, water requirement of crops, base period, kor period, Duty, Delta, Commanded area, Net Irrigation Requirement, Field Irrigation Requirement, Gross Irrigation Requirement, Intensity of irrigation, Consumptive use of water, estimation of evapotranspiration, Blaney-Criddle method, Modified Penman's method, Irrigation efficiencies, Frequency of irrigation.	6L
Module 4:	**Canal irrigation:** Classification of irrigation canals, canals in alluvium; Design of unlined canals: Kennedy's method, Lacey's method; Lined canals: advantages, materials used, typical sections, design of lined canals, economics of canal lining; Canal sections – filling, cutting, partial cutting and partial filling.	6L
Module 5:	**Land drainage:** Water logging issues in irrigation, provision of drains, design and maintenance of open drains, closed drains, discharge and spacing of closed drains.	4L
Module 6	**Groundwater:** Occurrence of groundwater– Aquifers, Various Types of Aquifers, Aquifer Parameters: Specific Yield, Specific Retention, Storage Coefficient, Transmissivity.	4L

Reference

Sl.	Book Name	Author	Publishing House
1	Irrigation and Water Power Engineering	B. C. Punmia, A. K. Jain and P. B. Lal	Laxmi Publications (P) Ltd., New Delhi, 2019.
2	Irrigation, Water Resources and Water Power Engineering	P. N. Modi	Standard Book House, New Delhi, 2019.
3	Irrigation Engineering and Hydraulic Structures	S. K. Sharma	S Chand Publishing, New Delhi, 2017.2012.
4	Irrigation Engineering	N. N. Basak	Tata McGraw Hill Education India Private Limited, 2017.
5	Irrigation and Water Resources Engineering	G. L. Asawa	New Age Publishers, New Delhi, 2005.

CE(PC)604	**Design of Steel Structures**	2L + 0T	2 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Identify the material properties of structural steel. Moreover, the students will identify different bolted and welded connections, analyse and design them for axial and eccentric loads. **2.** Design different steel sections subjected to axial compression and tension following Indian codes of practices. **3.** Comprehend the differences between laterally supported and unsupported flexure members. Designing of the flexure members using Indian codes of practice. **4.** Analyse and design rolled and built up compression members along with base connection subjected to axial compression, bending and tension. **5.** Calculate shear force and bending moment on rolled and built up girders, dimension the section and finally design it following Indian standard design guidelines. **6.** Identify different components of gantry system, calculate lateral and vertical loads acting on the system, dimension the components and design them. **7.** Design different components of an industrial building.		
Prerequisite	Introduction to Solid Mechanics (CE(ES)402)		
Module 1	**Materials and Specification:** Rolled steel sections, mechanical properties of steel and their specifications for structural use. Codes of practices. Design of Steel structures using **tubular**, rectangular and square section		1L
Module 2	**Structural connections:** Riveted, welded and bolted including High strength friction grip bolted joints. – types of riveted & bolted joints, assumptions, failure of joints ,efficiency of joints, design of bolted ,riveted & welded joints for axial load. Eccentric connection:- Riveted & bolted joints subjected to torsion & shear, tension & shear, design of riveted, bolted & welded connection.		6L
Module 3	**Design of Tension members:** Design of tension members, I.S code provisions. Permissible stresses, Design rules, Examples.		3L
Module 4	**Design of Compression members:** Effective lengths about major & minor principal axes, I.S code provisions. Permissible stresses, Design rules, Design of		6L

	one component, two components and built up compression members under axial load. Examples. Built up columns under eccentric loading: Design of lacing and batten plates, Different types of Column Bases- Slab Base , Gusseted Base, Connection details			
Module 5	**Design of Beams:** Permissible stresses in bending, compression and tension. Design of rolled steel sections, plated beams. simple Beam end connections, beam -Column connections. I.S code provisions			4L
Module 6	**Design of Plate girders:** Design of webs & flanges, Concepts of curtailment of flanges – Riveted & welded web stiffeners, web flange splices - Riveted, welded& bolted.			4L
Module 7	**Design of Gantry Girder**: Design gantry girder considering lateral buckling – I.S code provisions.			4L
IS Codes	1	IS 800 – 2007(Latest Revised code)		
	2	IS 875 – I (1987), II (1987), -III (2015), -IV(1987), V (1987)		
	3	S.P.: 6(1) – 1964 Structural Steel Sections		
	4	IS 1161 : 2014		
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Steel structures	N. Subramanian	OXFORD University Press
	2	Design Of Steel Structures	S.K.Duggal	TMH
	3	Design Of Steel Structures	Bhavikatti	I.K. Publishing House

CE(PE)601A	**Stability of Slopes**			2L + 0T	2 Credits
Course Outcome	On successful completion of this course, student should be able to: 1. Understand the fundamental theories and knowledge in the stability analysis of soil slopes. 2. Measure the finite and infinite slope stability. 3. Develop the analytical and numerical skills in treating a complicated practical slope problem. 4. Evaluate the safety and design proper slope protection measures. 5. Analyse the strength parameters in slope stability.				
Prerequisite	Introduction to Civil Engineering (CE(HS)302), Soil Mechanics – I (CE(PC)401), Soil Mechanics – II (CE(PC)504).				
Module 1	**Introduction:** slope failure- causes, short- and long-term failure.				2L
Module 2	**Landslides:** types, multiple and complex slides, rate of land movement, factor of safety, examples.				4L
Module 3:	**Slope stability analysis:** basic concepts, finite and infinite slopes, analysis of infinite slopes-dry or moist cohesive slope, non-cohesive slope, cohesive slope with seepage;				8L
Module 4:	**Analysis of finite slopes:** planar failure surface, circular failure surface, friction circle method, Taylors stability chart, locaton of critical circle, total stress analysis,				8L
Module 5:	**Method of Slices:** Fellenius method, Bishop's simplified method, effective stress stability chart.				4L
Module 6	Non-circular failure surfaces, selection of strength parameter in slope stability, various slope protection measures.				2L
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**	
	1	Soil Mechanics and Foundation Engineering	P. Purushothama Raj	Pearson publication	
	2	Principles of Foundation Engineering	Braja M. Das	Thomson Asia Pvt. Ltd., Singapore, 2005.	
	3	Soil strength and slope stability	J.M. Duncan, S.G. Wright	John Wiley & Sons (Imprint: Hoboken, N.J.), 2005.	
	4	Slope Analysis.	R. Chowdhury	Elsevier Scientific Publishing	
	5	The Stability of Slopes.	E.N. Bromhead	Blackie Academic & Professional	

CE(PE)601B	**Foundation Engineering**	2L + 0T	2 Credits
Course Outcome	On successful completion of this course, student should be able to:		

	1. Determine the load carrying capacity of pile foundation. **2.** Compute the efficiency and settlement of pile group. **3.** Understand different subsoil exploration methods and interpret field and laboratory test data to obtain design parameters for geotechnical analysis. **4.** Correlate bearing capacity of shallow foundation from field test data. **5.** Analyze and design sheet pile structure on the basis of earth pressure theories. 6. Understand and apply various types of ground improvement methods for solving complex geotechnical problems.			
Prerequisite	Introduction to Civil Engineering (CE(HS)302), Soil Mechanics – I (CE(PC)401), Soil Mechanics – II (CE(PC)504).			
Module 1	**Introduction** Classification, selection- shallow and deep foundations.			2L
Module 2	**Deep foundations** Pile foundation: Types of piles, material, Suitability and uses, Method of installation of piles - classification of piles based on material, Installation Techniques – Selection and uses, Determination of types and lengths of piles, Load transfer mechanism, Determination of load carrying capacities of piles by static and dynamic formulae as per IS codes, Pile spacing and group action, Group efficiency, Negative skin friction, Pile load test, Settlement of pile group, Lateral load capacity of pile by IS: 2911 and Reese & Matlock methods, Uplift capacity of pile - introduction.			9L
Module 3:	**Site Investigation & Soil Exploration** Planning of sub-surface exploration, Methods of boring, sampling, Different types of samples, Spacing, Depth and number of exploratory borings, Bore log, Preparation of sub-soil investigation report. **In-situ tests** Standard penetration test, Static cone penetration test, Dynamic cone penetration test, Field vane shear test, Plate load test. **Indirect methods of soil exploration** Geophysical method: seismic refraction and electrical resistivity methods.			6L
Module 4:	**Shallow Foundations** Bearing Capacity from SPT, SCPT and Plate load Test data.			3L
Module 5:	**Sheet pile structures** Type of sheet pilling, Design of sheet pile, Cantilever sheet piling, Anchored sheet piling, Free earth and fixed earth support methods, Analysis with anchored bulk heads.			4L
Module 6	**Introduction to Ground Improvement Techniques** Introduction, Economic considerations, Consolidation by preloading and sand drains, Stone columns, Compaction by vibro-floatation, Grouting techniques and principles, Applications of geo-synthetics, Ground anchors and soil nailing.			6L
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Textbook of Soil Mechanics and Foundation Engineering (Geotechnical Engineering Series)	V.N.S. Murthy	CBS Publishers
	2	Soil Mechanics and Foundations	Punmia, B.C. and Jain A. K	Laxmi Publications (P) Ltd
	3	Basic and Applied Soil Mechanics	Gopal Ranjan & A.S.R. Rao	New Age International Pvt.Ltd, Publishers
	4	Principles of Geotechnical Engineering	B.M. Das	Thomson Brooks / Cole
	4	Soil Mechanics and Foundation Engineering	P. Purushothama Raj	Pearson publication
	5	Soil strength and slope stability	J.M. Duncan, S.G. Wright	John Wiley & Sons (Imprint: Hoboken, N.J.), 2005.
	6	Slope Analysis.	R. Chowdhury	Elsevier Scientific Publishing
	7	The Stability of Slopes.	E.N. Bromhead	Blackie Academic & Professional

CE(PE)601C	**Ground Improvement Technique**	2L + 0T	2 Credits
Course Outcome	On successful completion of this course, student should be able to:		

	1. gain competence in properly devising alternative solutions to difficult and earth construction 2. evaluate their effectiveness before, during and after construction. 3. understand different approaches to the ground modification. 4. Understand the soil stabilisation for reinforced earth construction.			
Prerequisite	Introduction to Civil Engineering CE(HS)302, Soil Mechanics – II CE(PC)504, Soil Mechanics – I CE(PC)401.			
Module 1	**Introduction:** ground modification by vibro-replacement, stone columns, preloading and prefabricated drains, Reinforcedearth structures,			4L
Module 2	**Insitu densification:** Introduction, Compaction: methods and controls Densification of granular soil: Vibration at ground surface, Impact at ground surface, Vibration at depth (Vibroflotation), Impact at depth.			6L
Module 3:	**Geo-textiles:** Introduction to geotextiles and geomembranes, applications of geotextiles, design methods using geotextiles, geogrids, geonets, geomembranes, geotubes,			6L
Module 4:	**Grouting:** Over view: Suspension and Solution grout, Grouting equipment and methods, Grout design and layout, Grout monitoring schemes.			6L
Module 5:	**Soil stability:** Reinforced earth fundamentals, Soil nailing, Soil and Rock Anchors, Underpinning			4L
Module 6	**Densification of Cohesive Soils:** Preloading and dewatering, Design of Sand drains and Stone columns, Electrical and thermal methods.			4L
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Construction and Geotechnical methods in foundation engineering	R.M. Koener	McGraw Hill
	2	Reinforced Earth	T S Ingold	Thoam Telford
	3	Designing with Geosynthetics	R M Koerner	Prentice Hall
	4	Ground Improvement Techniques	P. Purushothama Raj	Laxmi Publications Pvt Limited, 2nd edition.
	5	Principles and Practice of Ground Improvement	Jie Han	Wiley publishers, 1st edition.

CE(PE)602A	**Building Construction Practice**	2L + 0T	2 Credits
Module 1	Specifications, details and sequence of activities and construction co-ordination – Site Clearance – Marking – Earthwork - masonry – stone masonry – Bond in masonry - concrete hollow block masonry – flooring – damp proof courses – construction joints – movement and expansion joints – pre cast pavements – Building foundations – basements – temporary shed – centering and shuttering – slip forms – scaffoldings – de-shuttering forms – Fabrication and erection of steel trusses – frames – braced domes – laying brick –– weather and water proof – roof finishes – acoustic and fire protection;		12L
Module 2	**Sub Structure Construction** Techniques of Box jacking – Pipe Jacking -under water construction of diaphragm walls and basement-Tunnelling techniques – Piling techniques - well and caisson - sinking cofferdam - cable anchoring and grouting-driving diaphragm walls, sheet piles - shoring for deep cutting - well points – Dewatering and stand by Plant equipment for underground open excavation;		10L
Module 3	**Super Structure Construction** Launching girders, bridge decks, off shore platforms – special forms for shells - techniques for heavy decks – in-situ pre-stressing in high rise structures, Material handling - erecting light weight components on tall structures - Support structure for heavy Equipment and conveyors -Erection of articulated structures, braced domes and space decks		8L

CE(PE)602B	**Structural Analysis – II**	2L + 0T	2 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Apply the Slope Deflection and Moment Distribution Method to analyze indeterminate		

	structures. **2.** Develop and analyze the concept of suspension bridge and stiffness girders **3.** Apply and analyze the concepts of curved beam analysis in hooks, rings and Bow girders. **4.** Develop the concept bending in unsymmetrical beams. **5.** Develop the fundamental concepts of plastic analysis using kinematic method and apply them in frames and continuous beam analysis. **6.** Develop and analyze the portal frames using Portal and Cantilever method. Develop and analyze the indeterminate structures (continuous beams and frames) using flexibility and stiffness matrix method.			
Prerequisite	Introduction to Solid Mechanics (CE(ES)402), Structural Analysis – I (CE(PC)503)			
Module 1	**Analysis of statically Indeterminate Structures:** Moment distribution method-solution of continuous beam, effect of settlement and rotation of support, frames with or without side sway. Slope deflection method: method and application in continuous beams and frames. Suspension Bridge and stiffening girders.			8L
Module 2	**Curved Beam analysis:** Hooks, rings and Bow girders. Unsymmetrical bending.			8L
Module 3	**Plastic analysis of structures:** beams and portal frames.			5L
Module 4	**Approximate method of analysis of structures:** Portal and Cantilever methods.			4L
Module 5	Matrix methods of structural analysis – Stiffness and flexibility approaches for analysis of beam.			5L
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Structural Analysis (Vol I & Vol II)	S S Bhavikatti	Vikas Publishing House Pvt. Ltd
	2	Structural Analysis	Ramammurtham	
	3	Strength of Materials and Theory of Structures (Vol I & Vol II)	Punmia, Jain, Jain	Laxmi Publication
	4	Structural Analysis	R.C. Hibbeler	Prentice Hall
	5	Theory of Structures	Timoshenko and Young	McGrawHill
	6	Structural Analysis	Pandit and Gupta	TMH
	7	Theory of Matrix Structural Analysis	J.S. Przemieniechki	DOVER PUBLICATIONS, INC.

CE(PE)602C	**Industrial Structure**	2L + 0T	2 Credits
Course Outcome	After going through this course, the students will be able to: 1. To perform the analysis and design of reinforced concrete members and their connections. 2. To identify and apply the industrial design codes relevant to the design of Reinforced concrete members. 3. To be familiar with the professional and contemporary design issues and fabrication of Reinforced concrete members.		
Prerequisite	Introduction to Solid Mechanics (CE(ES)402), Structural Analysis – I (CE(PC)503), Design of RC Structures (CE(PC)501)		
Module 1	**Overall Review of RC Design:** Review of Limit State Design of Beams, Slabs & Columns according to IS 456-2000. Yield line theory, Biaxial Bending & Slander Column. **Analysis and Design of beams curved in plan:** Design principle, structural design of beams curved in plan of circular and rectangular types. **Flat slabs:** Introduction, components – IS code provisions Design method – Design for flexure and shear and Detailing.		8L
Module 2	**Deep beams:** Introduction, Flexural and shear stresses in deep beam and Design and Detailing. **Water tank**: Introduction, Types, Analysis and Design of water tanks e.g. Underground & Elevated water tank (Circular, Rectangle and Intz)		7L
Module 3	**Raft Foundation:** Introduction, Types and Design of raft foundation. **Design of folded plate** **Design of shear wall** as per IS 13920		7L
Module 4	**Design of bunkers and silos:** Introduction, Difference between Bunkers and Silo (rectangular, square and circular bunker and silo design for storage of cement). **Analysis and design of chimneys:** Introduction and different type of linings, wind load calculation on chimney (Static and dynamic) Analysis and		8L

	design of chimney linings, foundation types.			
IS Codes	**1**	IS: 456 – 2000 (latest revision)		
	2	IS 875 – I (1987), II (1987), -III (2015), -IV(1987), V (1987)		
	3	SP: 16 Design Aid to IS 456		
	4	IS 1893-Part-I: 2016, IS 1893-Part-II: 2014		
	5	IS 3370 –I (1967), II (2009), III (1967), IV (1967)		
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	R.C.C. Design	B.C. Punmia	Laxmi Publication
	2	Reinforced concrete structures	N. Subramanian	OXFORD University Press
	3	Advanced Reinforced Concrete Design	P. C. Varghese	PHI
	4	Advanced Reinforced Concrete Design	N. KrishnaRaju	CBS Publishers

CE(OE)601A	**Soft Skills and Interpersonal Communication – I**	2L + 0T	2 Credits
Course Outcome	1. Analyse the dynamics of business communication and communicate accordingly. 2. Write business letters and reports 3. Learn to articulate opinions and views with clarity 4. Appreciate the use of language to create beautiful expressions 5. Analyse and appreciate literature. 6. Communicate in an official and formal environment.		
Module 1	Communication Skill Definition, nature & attributes of Communication Process of Communication Models or Theories of Communication Types of Communication Levels or Channels of Communication Barriers to Communication		3L
Module 2	Business Communication- Scope & Importance Writing Formal Business Letters Writing Reports Organizational Communication: Agenda & minutes of a meeting, notice, memo, circular Project Proposal Technical Report Writing Organizing e-mail messages E-mail etiquette Tips for e-mail effectiveness		8L
Module 3	Language through Literature Modes of literary & non-literary expression Introduction to Fiction, (An Astrologer's Day by R.K. Narayan and Monkey's Paw by W.W. Jacobs), Drama (The Two Executioners by Fernando Arrabal) or (Lithuania by Rupert Brooke) & Poetry (Night of the Scorpion by Nissim Ezekiel and Palanquin Bearers by Sarojini Naidu)		8L
Module 4	Grammar in usage (nouns, verbs, adjectives, adverbs, tense, prepositions, voice change) - to be dealt with the help of the given texts.		10L

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Theories of Communication: A Short Introduction	Armand Matterlart and Michele Matterlart	Sage Publications Ltd
	2	Professional Writing Skills	Chan, Janis Fisher, and Diane Lutovich	San Anselmo, CA: Advanced Communication Designs, 1997.
	3	Writing and Speaking at Work: A Practical Guide for Business Communication	Edward P.Bailey	Prentice-Hall
	4	Intercultural Business Communication	Lillian Chaney and Jeanette Martin	Prentice Hall

CE(OE)601B	**Introduction to Philosophical Thoughts**	2L + 0T	2 Credits
Module 1	Introduction to Indian Philosophy: Brief discussion on Veda and Upanishads; Origin of Indian Philosophy		1L
Module 2	Charvaka Philosophy: Epistemology; Metaphysics		2L
Module 3	Samkhya Philosophy: Metaphysics; Theory of Causation. --Prakṛti, Purusa, Evolution; Epistemology		3L
Module 4	Yoga Philosophy: Organization of the YogaSutras; Psychology of Yoga -- Stages of Citta, Forms of Citta, Modifications of Citta, Kinds of Klesas; The Eight-Fold Yoga; God and Liberation		3L
Module 5	Nyaya Philosophy : Epistemology -- Perception (Pratyaksa), Inference		5L

	(Anumāna), Comparison (Upamāna), Testimony (Sabda); Theory of Causation (Asatkāryavāda); Self and Liberation; The Concept of God	
Module 6	Mimansa Philosophy: Epistemology -- Validity of Knowledge; Sources of Valid Knowledge (Pramāna) – Perception, Inference, Comparison, Verbal Testimony, Postulation (Arthapati), Non Apprehension (Anupalabdhi); Theories of Error (Khyativāda) – Akhyativāda, AnirvacaniyaKhytivāda, Viparitakhyativāda; Metaphysics -- Theory of Causation; Nature of Self; God and Liberation	4L
Module 7	Vaisesika Philosophy: Metaphysics and the Categories -- Substance (Dravya), Quality (Guṇa), Action (Karma), Generality (Sāmānya), Particularity (Vaiśeṣa), Inherence (Samavāya), Nonexistence (Abhāva); Epistemology; The Concept of God; Bondage and Liberation	3L
Module 8	Buddhist Philosophy:Epistemology -- Dependent Origination; Four Noble Truths; Eight Fold Paths; Ethics; Karma and Rebirth; Liberation	4L
Module 9	Jaina Philosophy: Syādavāda; Anekāntavāda; Ethics; Karma and Liberation	3L

CE(PC)693	**Water Resource Engineering Laboratory**	2P	1 Credits
Course Outcome	On completion of the course, the students will be able to: **14.** Delineate the watershed of any reservoir using DEM. **15.** Determine the average rainfall over a catchment. **16.** Use the raingauge properly for a specified purpose. **17.** Measure the rate of infiltration of water through the soil. **18.** Measure the sunshine hours in a particular day.		
Prerequisite	Engineering Hydrology CE(PC)502 & Water Resources Engineering CE(PC)603		
Experiment 1	Catchment area delineation (Manually and using DEM)		
Experiment 2	Calculation of average rainfall over a catchment area with arithmetic mean method, Thiessen polygon method and Isohyetal Method.		
Experiment 3	Use of different type of Rain gauges.		
Experiment 4	Measurement of infiltration rate using double ring infiltrometer.		
Experiment 5	Measurement of evaporation using evaporimeter.		
Experiment 6	Measurement of bright sunshine hours using sunshine recorder.		

CE(PC)694	**Steel Structure Design Sessional**	2P	1 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Identify the material properties of structural steel. Moreover, the students will identify different bolted and welded connections, analyse and design them for axial and eccentric loads. **2.** Design different steel sections subjected to axial compression and tension following Indian codes of practices. **3.** Comprehend the differences between laterally supported and unsupported flexure members. Designing of the flexure members using Indian codes of practice. **4.** Analyse and design rolled and built up compression members along with base connection subjected to axial compression, bending and tension. **5.** Calculate shear force and bending moment on rolled and built up girders, dimension the section and finally design it following Indian standard design guidelines. **6.** Identify different components of gantry system, calculate lateral and vertical loads acting on the system, dimension the components and design them. **7.** Design different components of an industrial building.		
Prerequisite	Design of Steel Structures (CE(PC)604		
	Design of a factory shed including preparation of necessary working drawings and report in accordance with CE(PC)604		

CE(PC)695	**Quantity Survey Estimation and Valuation Sessional**	1T+2P	2 Credits
Course Outcome	The subject aims to provide the student with: 1. An introduction to quantity surveying 2. The capability to know analysis and schedule of rates		

	3. The ability to know specification of materials 4. An understanding about specification of works 5. The introduction to valuation
Prerequisite	Introduction to Civil Engineering [CE(HS)302], Construction Engineering & Management [CE(PC)601], Engineering Economics, Estimation & Costing [CE(PC)602]
	1. Quantity Surveying: Types of estimates, approximate estimates, items of work, unit of measurement, unit rate of payment. 2. Quantity estimate of a single storied building 3. Bar bending schedule. 4. Details of measurement and calculation of quantities with cost, bill of quantities, abstract of quantities. 5. Estimate of quantities of road, Underground reservoir, Surface drain, Septic tank. 6. Analysis and schedule of rates: Earthwork, brick flat soling, DPC, PCC and RCC, brick work, plastering, flooring and finishing, 7. Specification of materials: Brick, cement, fine and coarse aggregates 8. Specification of works: Plain cement concrete, reinforced cement concrete, first class brickwork, cement plastering, pointing, white washing, colour washing, distempering, lime punning, painting and varnishing 9. Valuation: Values and cost, gross income, outgoing, net income, scrap value, salvage value, market value, Book Value, sinking fund, capitalised value, Y. P., depreciation, obsolescence, deferred income, freehold and leasehold property, mortgage, rent fixation, valuation table

Semester VII [Fourth year]

CE(OE)701A	**Metro System and Engineering**	2L + 0T	2 Credits
Module 1	Overview of Metro Systems; Need for Metros; Routing studies; Basic Planning and Financial		4L
Module 2	**CIVIL ENGINEERING** Overview and construction methods for: Elevated and underground Stations; Viaduct spans and bridges; Underground tunnels; Depots; Commercial and Service buildings. Initial Surveys & Investigations; Basics of Construction Planning & Management, Construction Quality & Safety Systems. Traffic integration, multimodal transfers and pedestrian facilities; Environmental and social safeguards; Track systems-permanent way. Facilities Management		12L
Module 3:	**ELECTRONICS AND COMMUNICATION ENGINEERING** Signaling systems; Automatic fare collection; Operation Control Centre (OCC and BCC); SCADA and other control systems; Platform Screen Doors.		5L
Module 4:	**MECHANICAL & TV + AC** Rolling stock, vehicle dynamics and structure; Tunnel Ventilation systems; Air conditioning for stations and buildings; Fire control systems; Lifts and Escalators		5L
Module 5:	**ELECTRICAL**: OHE, Traction Power; Substations- TSS and ASS; Power SCADA; Standby and Back-up systems; Green buildings, Carbon credits and clear air mechanics		5L

CE(OE)701B	**ICT for Development**	2L + 0T	2 Credits
Module 1	Introduction to ICT: New media and ICT, Different types of ICT. Use of ICT for development; e-learning; Web commerce; Mobile telephony and Development: telecom industry in India. ICT Projects implemented in India and Northeast – Problems and Prospects		7L
Module 2	Digital Revolution and Digital Communication: Basics of New media theories – Information Society; Surveillance society; Digital Divide, Knowledge society; Network society. Works of Machlup, Bell, Negroponte and Castells		6L
Module 3:	Technology and Development: ICT for Development its societal implications; Evolution of ICT in Development Endeavour; ICT and Millennium Development Goals. Democratic and decentralized processes in development. Technology and culture: community and identity; participatory culture and ICT, community informatics		8L
Module 4:	Computer Mediated Communication and development:Different types of CMC; Important theoretical framework of CMC, cyber platform and communities, Social Networking Site; Convergent media, Multimedia platforms, Scope of convergent journalism for Development; Characteristics of convergent journalism; Different types of convergent journalism: precision journalism; annotative and open-source		10L

	journalism; wiki journalism; open source journalism; citizen journalism; back-pack journalism, Convergent technologies and applications; Multimedia convergence and Interactivity	

CE(OE)701C	**Cyber Law & Ethics**			2L + 0T	2 Credits
Module 1	Introduction: Basics of Law, Understanding Cyber Space, Defining Cyber Laws, Scope and Jurisprudence, Concept of Jurisdiction, Cyber Jurisdiction, Overview of Indian Legal System, Introduction to IT Act 2000, Amendments in IT Act, Cyber Laws of EU – USA – Australia - Britain, other specific Cyber laws				6L
Module 2	Computer Ethics, Privacy and Legislation: Computer ethics, moral and legal issues, descriptive and normative claims, Professional Ethics, code of ethics and professional conduct. Privacy, Computers and privacy issue, Digital Evidence Controls, Evidence Handling Procedures, Basics of Indian Evidence ACT, Legal Policies, legislative background				7L
Module 3:	Intellectual Property Rights Issues: Copyrights, Jurisdiction Issues and Copyright Infringement, Multimedia and Copyright issues, WIPO, Intellectual Property Rights, Understanding Patents, Understanding Trademarks, Trademarks in Internet, Domain name registration, Software Piracy, Legal Issues in Cyber Contracts, Authorship, Document Forgery				7L
Module 4:	Indian IT Act and Standards: Indian IT ACT, Adjudication under Indian IT ACT, IT Service Management Concept, IT Audit standards, ISO/IEC 27000 Series, COBIT, HIPPA, SOX, System audit, Information security audit, ISMS, SoA (Statement of Applicability), BCP (Business Continuity Plan), DR (Disaster Recovery), RA (Risk Analysis/Assessment)				6L
Module 5:	International Laws governing Cyber Space: Introduction to International Cyber Law, UNCITRAL, Cyber Laws: Legal Issues and Challenges in India, Net neutrality, Role of INTERPOL.				4L
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**	
	1	Computer Ethics	Deborah G. Johnson	Pearsons Education	
	2	Cyber Law Simplified	Vivek Sood	McGraw Hill Education	
	3	Cyber frauds, cybercrimes & law in India	Pavan Duggal,	Saakshar Law Publications	
	4	The Internet Law of India: Indian Law Series	Shubham Sinha	CreateSpace Independent Publishing Platform	

CE(PE)701A	**Computational Hydraulics**	2L + 1T	3 Credits
Course Outcome	On successful completion of this course, student should be able to: 7. Identify the complexities involved in fluid flow problems. 8. Model the specific flow problem in terms of defining the governing equations, initial and boundary conditions and appropriate solution schemes to use. 9. Develop finite difference formulation of ordinary and partial differential equations of flow problems. 10. Develop finite volume formulation of ordinary and partial differential equations of flow problems.		
Prerequisite	Introduction to Civil Engineering CE(HS)302, Introduction to Fluid Mechanics CE(ES)401, Water Resources Engineering CE(PC)603,		
Module 1	**Introduction:** Modelling Theory - Physical modelling, analytical modelling, numerical modelling; classification of models based on i) Scale (space and time), ii) Solution (analytical and numerical); Concept of computational hydraulics; Processes involved in model development and application.		4L
Module 2	**Modelling Fluid Flow Problems:** Governing equations- Conservation of mass, conservation of momentum, conservation of energy; Mathematical classification of flow equations, solution of ordinary differential equations and partial differential equations, boundary conditions; Solution of Saint-Venant Equations - Kinematic wave solution, Diffusive wave solution and full dynamic solution; Characteristic form of Saint-Venant Equations.		8L
Module 3:	**Numerical Solution Schemes:** Discrete solution of governing equations, Space discretization - Structured grids and unstructured grids, grid generation, time discretization.		2L
	Finite Difference Method: General concept, approximation of derivatives; Finite difference formulation for ordinary differential equations - Explicit		8L

	schemes, Implicit schemes, Mixed schemes and weighted average schemes; Finite difference formulation for partial differential equations - initial conditions, boundary conditions, explicit and implicit schemes; The Preissmann Scheme, The Abbott-Ionescu scheme.	
	Example Applications: Ordinary differential equation - Solution of linear reservoir problem; Partial differential equation - Solution of simple wave propagation, Solution of diffusion equation.	6L
Module 4:	**Finite Volume Method:** General concept, Steps in application of Finite Volume Method- Surface and volume integrals, Discretization of convective fluxes, Discretization of diffusive fluxes, evaluation of time derivative, boundary conditions.	8L
	Example Application: Solution of Advection-Diffusion Equation in 1-D.	4L

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Computational Hydraulics	M. B. Abbott and A. W. Minns	Routledge, London, 2016
	2	Computational Hydraulics – An Introduction	C. B. Vreugdenhil,	Springer – Verlag, New York, 1989
	3	Computational Hydraulics	C. A. Brebbia and A. J. Ferrante,	Butterworth-Heinemann, 2013.
	4	Computational Methods for Fluid Dynamics,	J. H. Ferziger and M. Peric	Springer, London, 2002.

CE(PE)701B	**Disaster Preparedness and Planning**	2L + 1T	3 Credits
Course Outcome	On completion of the course the students will be able to: **1.** Define the basic concepts and terminologies disaster management **2.** Understand and describe the categories of disaster **3.** Realize the roles and responsibilities of a civil engineer towards society in time of a disaster **4.** Analyze relationship between development and disasters **5.** Apply different concepts of disaster management		
Prerequisite	Class-X level knowledge of Indian Geography and Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level introductory knowledge of Civil and Environmental Engineering		
Module 1	**Introduction, Basic Concepts and Definitions** Disaster, Hazard, Vulnerability, Risks, Severity, Frequency and details, Capacity, Impact, Prevention, Mitigation		3L+1T
Module 2	**Disasters and their Classification** Natural Disasters: Floods, Draught, Cyclones, Volcanoes, Earthquakes, Tsunami, Landslides, Coastal Erosion, Soil Erosion, Forest Fires Manmade Disasters: Industrial Pollution, Artificial Flooding in Urban Areas, Nuclear Radiation, Chemical Spills, Transportation Accidents, Terrorist Strikes Hazard and vulnerability profile of India, Mountain and coastal areas, Ecological fragility		5L+3T
Module 3:	**Disaster Impacts** Disaster Impacts: Environmental, Physical, Social, Ecological, Economic, Political Health, Psycho-social issues; Demographic aspects (gender, age, special needs); Hazard locations; Global and national disaster trends; Climate change and urban disasters.		7L+3T
Module 4:	**Disaster Risk Reduction (DRR)** Phases of disaster management cycle; Prevention, Mitigation, Preparedness, Relief and recovery; Structural and non-structural measures; Risk analysis, Vulnerability and capacity assessment; Early warning systems, Post-disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR		7L+3T

	programmes in India and the activities of National Disaster Management Authority			
Module 5:	**Disasters, Environment and Development** Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land use changes, urbanization etc.), Sustainable and environmental friendly recovery; Reconstruction and development methods			6L+4T
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Disaster Risk Reduction in South Asia	Pradeep Sahni	Prentice Hall
	2	Handbook of Disaster Management: Techniques & Guidelines	Singh B.K.	Rajat Publication
	3	Disaster Medical Systems Guidelines	Emergency Medical Services Authority	State of California, EMSA no.214, June 2003
	4	IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings	Inter Agency Standing Committee (IASC) (Feb. 2007).	
	5	http://ndma.gov.in/ (Home page of National Disaster Management Authority)		
	6	http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs)		

CE(PE)701C	**Hydraulic Structures**	2L + 1T	3 Credits
Course Outcome	On successful completion of this course, student should be able to: 1. Identify the characteristics of various types of dams and their selection procedure. 2. Perform the reconnaissance survey and, geophysical investigations necessary for selection of suitable dam site 3. Estimate forces acting on a gravity dams and perform stability analysis. 4. Estimate the seepage loss through embankment dams and suggest necessary remedial measures. 5. Calculate the discharge through the overflow section and design the appropriate energy dissipation structures.		
Prerequisite	Introduction to Civil Engineering CE(HS)302, Water Resources Engineering CE(PC)603,		
Module 1	**Storage Structures:** Dams, Types of Dams – Embankment dams, gravity dams, various components and their functions		1L + 1T
Module 2	**Selection of Dam Site:** Site investigations, initial study, reconnaissance survey, geophysical investigations, preliminary selection, evaluation of selected site - various types of foundation testing, field testing and borrow pit investigations, detailed investigations; assessment of foundation characteristics and suitability; selection of type of dam.		4L + 2T
Module 3:	**Gravity Dam:** Definition, Features of some important gravity dams, Forces acting on a gravity dam, estimation of forces due to: self-weight, water pressure on upstream and downstream face, Uplift pressure, wave pressure, silt pressure, wind pressure, earthquake forces, hydrodynamic forces; Stability analysis - load combinations, codal provisions, modes of failures - overturning, sliding, tension and compression failures, factors of safeties, principal stresses; Elementary profile of a gravity dam - forces acting, minimum base width - no tension, no sliding basis, principal stresses.		8L + 4T
	Embankment Dams: Definitions, Features of some important embankment dams; Types of embankment dams and their sectional features; Design criteria; Freeboard - necessity, estimation procedure; Seepage analysis - Laplace's flow equations, drainage blanket and rock toe, phreatic line, graphical procedure of drawing phreatic line, estimation of seepage loss; Stability analysis of embankment dams – slip circle method; Seepage Control - cut-offs, slurry trench, sheet piling, grouting, slope protection.		6L + 2T
	Diversion headworks: Necessity and uses, different types, layout and different components; weirs on permeable foundation, Creep theories, Khosla's method; Different types of modules, Canal escapes, Silt control devices.		5L + 3T
Module 4:	**Spillways and Energy Dissipation Structures:** Necessity, types, selection, spillway gates; High overflow ogee spillway - profile, discharge computation, flow equations, factors affecting coefficient of discharge, codal provisions. stilling basins (USBR and BIS) types		4L + 2T
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Hydraulic Structures	Novak, A. I. B. Moffat, C.	E & FN Spon, UK, 2010.

			Nalluri and R. Narayan P	
	2	Hydraulic Structures	S. H. Chen	Springer Nature, USA, 2015.
	3	Irrigation Engineering and Hydraulic Structures	S. K. Sharma	S. Chand Publishing, New Delhi, 2017.
	4	Dams and Appurtenant Hydraulic Structures	A. Tanchev	CRC Press, USA, 2014.
	5	Fluid Mechanics and Hydraulic Machines	K. Subramanya	McGraw Hill Education (India) Private Limited, New Delhi, Chennai, 2019.

CE(PE)702A	**Prestressed Concrete**	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Learn the introduction of prestressed concrete member and its deflection properties **2.** Develop the design criteria of prestressed concrete section for flexure and shear properties **3.** Analyze the anchorage zone stress for post-tensioned members **4.** Impart knowledge regarding the methods of Analysis of Statically Indeterminate Structures. **5.** Impart knowledge regarding the composite construction of Prestress and In-situ concrete. **6.** Impart knowledge regarding Design of Prestressed concrete poles and sleepers and introduction of partial prestressing.		
Prerequisite	Introduction to Solid Mechanics (CE(ES)402), Structural Analysis – I (CE(PC)503), Design of RC Structures (CE(PC)501)		
Module 1	**Introduction of Prestressed concrete:** Materials, prestressing system, analysis of prestress and bending stress, losses Shear and torsional resistance: design of shear reinforcement, design of reinforcement for torsion shear and bending. **Deflections of prestressed concrete members:** Importance, factors, short term and long term deflection		8L+4T
Module 2	**Shear and Torsional Resistance:** Design of Shear Reinforcement, Design of Reinforcement for Torsion, Shear and Bending. **Limit State Design Criteria:** Inadequacy of Elastic and Ultimate Load Method, Criteria for Limit States, Strength and Serviceability. **Design of Prestressed Concrete Section:** for Flexure & methods by Lin and Magnel		8L+4T
Module 3	**Anchorage Zone stresses in post tensioned members:** Stress distribution in end block, anchorage zone reinforcement		3L+1T
Module 4	**Statically Indeterminate Structures:** Advantages of Continuous Member, Effect of Prestressing, Methods of Achieving Continuity and Method of Analysis of Secondary Moments		4L+2T
Module 5	**Composite Construction of Prestressed and In-situ Concrete:** Types, Analysis of Stresses		3L+1T
Module 6	**Prestressed Concrete Poles and Sleepers:** Design of Sections for Compression and Bending. Introduction to Partial Prestressing.		2L+2T
IS Codes	**1** IS: 1343 : 2012		

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Prestressed Concrete	N. KrishnaRaju	TMH
	2	Prestressed Concrete	Ramamuthram	Dhanpat Rai Publishing Company
	3	Fundamentals of Prestressed Concrete	N.C.Sinha and S.K.Roy	S. Chand
	4	Prestressed Concrete	Karuna Moy Ghosh	PHI
	5	Design of Prestressed Structures	T.Y.Lin and N.H.Burns	

CE(PE)702B	**Repair & Rehabilitation of Structures**	2L + 1T	3 Credits
Course Outcome	By the end of this course students will have the capability/knowledge of **1.** Various distress and damages to concrete and masonry structures **2.** The importance of maintenance of structures, types and properties of repair materials etc **3.** Assessing damage to structures and various repair techniques		
Prerequisite	Introduction to Solid Mechanics (CE(ES)402), Structural Analysis – I (CE(PC)503), Design of RC Structures (CE(PC)501), Concrete Technology (CE(PC)405).		
Module 1	**Introduction:** Overview of distress, deterioration in concrete structures, Scenario of distressed structures world over, Need for repairs and upgrading of		3L+1T

	structures, General introduction to process (Road-map) to a durable concrete repair	
Module 2	**Deterioration of concrete structures**: Types of deterioration – Signs, causes & symptoms, Mechanism of deterioration, contributing factors like permeability, inadequate durability & micro-structure of concrete. Physical deterioration due to moisture, temperature, shrinkage, freeze-thaw, abrasion, erosion, cavitation, crystallization of salts, Efflorescence, exposure to severe environment like marine exposure. Chemical deterioration due to corrosion of reinforcement (chloride induced, carbonation induced), Alkali-silica reaction, sulphate attack, Acid attack Deterioration due to water leakage, fire – detection & mitigation of the same. Deterioration due to ageing, inadequate maintenance, Design & construction deficiencies, overloading etc. Types of cracks, causes & characteristics of cracking in various structural components like beam, column, slab, masonry walls. Measurement of cracks, interpretation of the cause of particular type of crack.	6L+3T
Module 3	**Conditional/damage assessment & Evaluation of structures**: Structural assessment: Conditional evaluation / Structural Appraisal of the structure – Importance, objective & stages, Conditional/damage assessment procedure, Preliminary & Detailed investigation – Scope, Objectives, Methodology & Rapid visual inspection of structures **Damage Assessment allied Tests (Destructive, Semi-destructive, Nondestructive):** Field & laboratory testing procedures for evaluating the structure for strength, corrosion activity, performance & integrity, durability. Interpretation of the findings of the tests	6L+3T
Module 4	**Repairs, rehabilitation & Retrofitting of concrete structures:** Repair materials - Criteria for durable concrete repair, Methodology, performance requirements, repair options, selection of repair materials, Preparatory stage of repairs, Different types of repair materials & their application, types of repair techniques. **Retrofitting/Strengthening:** Need for retrofitting, Design philosophy of strengthening structures, Techniques available for strengthening including conventional and advanced techniques. **Seismic retrofit of concrete structures**: Deficiencies in structure requiring seismic retrofit, Design philosophy, Techniques to enhance the seismic resistance of structures, advanced techniques for making seismic resistant structures	9L+3T
Module 5	**Protection & maintenance of structures** - Importance of protection & maintenance, Categories of maintenance, Building maintenance. Corrosion mitigation techniques to protect the structure from corrosion. **Long term health monitoring / Structural health monitoring (SHM)**– Definition and motivation for SHM, Basic components of SHM and its working mechanism, SHM as a tool for proactive maintenance of structures.	4L+2T

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Handbook on repair and rehabilitation of RCC buildings	CPWD, Government of India	
	2	Failures and repair of concrete structures	S. Champion	John Wiley and Sons
	3	Diagnosis and treatment of structures in distress	R.N.Raikar	R & D Centre of Structural Designers and Consultants Pvt.Ltd
	4	Handbook on seismic retrofit of buildings	A. Chakrabarti et.al	Narosa Publishing House
	5	Repair and protection of concrete structures	Noel P. Mailvaganam	CRC Press
	6	Concrete repair and maintenance	Peter.H.Emmons	Galgotia publications
	7	Maintanance, Repair & Rehabilitation and Minor works in Building	P.C. Varghese	PHI
	8	Concrete Structures Repair Rehabilitation and Retrofitting	J Bhattacharjee	CBS
	9	Repair & Rehabilitation of Concrete Structures	Modi and Patel	PHI

CE(PE)702C	**Finite Element Method**	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: 1. Obtain an understanding of the fundamental theory of the FEA method. 2. Develop the ability to generate the governing FE equations for systems governed by partial differential equations.		

	3. Understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements and			
Prerequisite	Basic Mathematics			
Module 1	**Introduction to Finite Element Analysis:** Basic Concepts of Finite Element Analysis and its necessity			2L
Module 2	**Numerical tools for Finite Element Formulation**: Variational Principle: Ritz method, Weighted residual method: Galerkin approach, Petrov-Galerkin approach.			5L+2T
Module 3	**Finite element Formulation:** Formulation of Euler-Bernoulli beam element and Timoshenko beam element, Imposition of boundary conditions.			7L+3T
Module 4	**Elements and their properties:** One dimensional and Two dimensional elements (Bar element, Beam element, Plate element), Interpolation functions, Numerical integration.			7L+3T
Module 5	**Finite element solutions:** Formulation of stiffness matrix and solution of beam, plate and truss problems, Problems on Plates with cutout. Introduction to the software SAP2000.			7L+4T
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	An Introduction to the Finite Element Method	Reddy J.N	McGraw Hill Publication
	2	Matrix and Finite Element Analyses of Structures	Mukhopadhyay	Oxford and IBH Publishing Co. Pvt. Ltd
	3	Concepts and Applications of Finite Elements Analysis	Cook R.D, Malkus, Plesha and Witt	Wiley
	4	Finite Element Analysis: Theory and Programming	Krishnamoorty C. S.	McGraw Hill Publication
	5	Introduction to Finite Elements in Engineering	Chandrupatla and Belegundu	PHI
	6	Finite Element Method with Applications in Engineering	Desai	Pearson
	7	Finite Element Procedures	Bathe	PHI

CE(PE)703A	**Air and Noise Pollution and Control**	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: **1.** Define the basic concepts and terminologies regarding air pollution and noise pollution **2.** Describe the physics of air pollution and noise pollution **3.** Apply the methods of air pollution and noise pollution measurements **4.** Analyze different concepts of air and noise pollution solving mathematical problems **5.** Compare air and noise quality with allowable standards and limits **6.** Choose and design proper techniques for air pollution control and noise pollution control		
Prerequisite	Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Statistics and Environmental Engineering		
Module 1	**Air Pollutants** Sources; Classification; Effects on Human, Vegetation, Material Effects of Air pollution on Atmosphere: Photochemical Smog, Ozone Layer Depletion, Acid Rain, Greenhouse Effect and Global Warming		4L+2T
Module 2	**Air Pollution Meteorology** Lapse Rate; Atmospheric Stability; Inversion; Plume Pattern		3L+1T
Module 3	**Dispersion of Air Pollutants** Point Source Gaussian Plume Model, Stability Classes, Stability Charts, Design of Stack Height		3L+1T
Module 4	**Air Quality** Methods of Measurement: Gaseous pollutants, Particulate pollutants Air Quality Standards and Indices: Ambient Air Quality Standard, NAAQS, Emission Standard, Air Quality Indices		4L+2T
Module 5	**Air Pollution Control** Control of Gaseous Pollutants: Adsorption, Absorption, Condensation Control of Particulate Pollutants: Settling chambers, Cyclone separators, Wet collectors, Fabric filters, Electrostatic precipitators Control of Pollution from Automobiles		5L+3T
Module 6	**Physics of Noise** Basics of Acoustics; Sound Pressure, Power and Intensity and their Interrelations		1L+1T
Module 7	**Measurement of Noise** Noise Level; Interrelation between Noise, Pressure, Power and Intensity Levels; Noise Meter; Noise Networks; Frequency Band Analysis; Decibel		4L+2T

	Addition Measurement of Community Noise: L_N, L_{eq}, L_{dn},, L_{NP}			
Module 8	**Source and Effect of Noise** Psychoacoustics and noise criteria; effects of noise on health; annoyance rating schemes			1L+1T
Module 9	**Noise Pollution Control** Noise Standards and Limits; Methods of Noise Pollution Control			3L+1T
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Introduction to Environmental Engineering and Science	Masters, G.M., Ela, W.P.	Prentice Hall / Pearson
	2	Environmental Engineering: A Design Approach.	Sincero, A., Sincero, G.	Prentice Hall
	3	Environmental Engineering. Volume-1 and Volume-2.	Garg, S.K.	Khanna Publishers
	4	Air Polution	Rao, M.N., Rao, H.V.N.	Tata McGraw Hill

CE(PE)703B	**Physico-Chemical Processes for Water and Wastewater Treatment**	2L + 1T	3 Credits
Course Outcome	On completion of the course the students will be able to: **1.** Define the basic concepts and terminologies regarding physico-chemical treatment of water and wastewater **2.** Describe the physics, chemistry and hydraulics of different unit operations and processes for water and wastewater treatment **3.** Analyze different physico-chemical water and wastewater treatment options solving mathematical problems **4.** Design different physico-chemical treatment processes to treat water and wastewater		
Prerequisite	Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Engineering Physics, Engineering Chemistry, Fluid Mechanics and Hydraulics and Environmental Engineering		
Module 1	**Introduction and Basic Concepts** Water purification in natural systems, physical processes, chemical processes and biological processes; Primary, secondary and tertiary treatment; Unit operations, unit processes		2L+2T
Module 2	**Aeration** Aeration and Gas Transfer		2L
Module 3	**Sedimentation** Sedimentation, different types of settling; sedimentation tank design		3L+1T
Module 4	**Clariflocculation** Coagulation and flocculation; Coagulation processes, Stability of colloids; Destabilization of colloids; Destabilization in water and wastewater treatment; Transport of colloidal particles; Design aspects		4L+2T
Module 5	**Filtration** Filtration processes; Hydraulics of flow through porous media; Rate control patterns and methods; Filter effluent quality parameters; Mathematical model for deep granular filters; Slow sand filtration, Rapid sand filtration, Precoat filtration; design aspects		4L+2T
Module 6	**Disinfection** Types of disinfectants; Kinetics of disinfection; Chlorination and its theory; Design of Chlorinators		3L+1T
Module 7	**Precipitation** Hardness removal; Iron, Manganese, and Heavy metal removal		3L+1T
Module 8	**Adsorption** Adsorption equilibria and adsorption isotherm; Rates of adsorption; Sorption kinetics in batch reactors; Continuous reactors; Factors affecting adsorption		3L+1T
Module 9	**Ion Exchange Processes** Materials and reactions; Methods of operation; Application; Design aspects		3L+1T
Module 10	**Membrane Processes** Reverse osmosis, Ultrafiltration, Electrodyalisis		3L+1T

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Environmental Engineering. Volume-1 and Volume-2.	Garg, S.K.	Khanna Publishers
	2	Environmental Engineering: A Design Approach.	Sincero, A., Sincero, G.	Prentice Hall

	3	Environmental Engineering	Peavy, H.S, Rowe, D.R, Tchobanoglous, G	Tata McGraw Hill Indian Edition
	4	Manual on Water Supply and Treatment	CPHEEO	Govt. of India
	5	Manual on Sewerage and Sewage Treatment	CPHEEO	Govt. of India
	6	Manual on Municipal Solid Waste Management.	CPHEEO	Govt. of India
	7	*Water Works Engineering: Planning, Design and Operation*	Qasim, S.R., Motley, E.M., Zhu, G.	Prentice Hall
	8	*Waste Water Treatment Plants: Planning, Design and Operation*	Qasim, S.R.	CRC Press
	9	*Water Engineering: Hydraulic, Distribution and Treatment.*	Shammas, N.K., Wang, L.K.	Wiley
	10	*Water Quality Engineering: Physical / Chemical Treatment Processes.*	Benjamin, M.M., Lawler, D.F.	Wiley

CE(PE)703C	**Water and Air Quality Modelling**	2L + 1T	3 Credits
Course Outcome	On completion of the course the students will be able to: 1. Define the basic concepts and terminologies regarding water and air quality modelling 2. Describe the background mechanisms in modeling water and air quality 3. Analyze different water and air quality models solving mathematical problems 4. Apply the concepts of air and water quality modeling in air and water pollution control and management		
Prerequisite	Class-XII level knowledge of Physics, Chemistry, Mathematics, Biology and Environmental Science; Undergraduate level knowledge of Engineering Statistics, Engineering Physics, Engineering Chemistry, Fluid Mechanics and Hydraulics and Environmental Engineering		
Module 1	**Introduction to Water Quality Models** Introduction to mathematical models; Water quality model development; Calibration and verification; Cost benefit analysis using models; Model requirements and limitations		4L+2T
Module 2	**Dissolved Oxygen Model for Streams** Sources and sinks of dissolved oxygen; Estimation of system parameters; Streeter Phelps model, oxygen 'sag' curve, Determination of deoxygenation and re-aeration coefficients; Benthal oxygen demand; Mass transport mechanisms		6L+2T
Module 3	**Models for Estuary and Lakes** Physical chemical and biological processes in estuaries and lakes		4L+2T
Module 4	**Introduction to Air Quality Models** Micrometeorological processes, Wind rose, Dispersion, coefficients and Stability classes		4L+2T
Module 5	**Dispersion Models** Point Source Gaussian Dispersion Model, Stack height computation; Line Source Models; Box Models		7L+3T
Module 6	**Air Quality Models** Regional air quality models, Source inventories and significance		4L+2T

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Environmental Engineering. Volume-1 and Volume-2.	Garg, S.K.	Khanna Publishers
	2	Environmental Engineering	Peavy, H.S, Rowe, D.R, Tchobanoglous, G	Tata McGraw Hill Indian Edition
	3	Introduction to Environmental Engineering and Science.	Masters, G.M., Ela, W.P.	Prentice Hall / Pearson

CE(PE)704A	**Structural Dynamics**	2L + 1T	3 Credits
Course Outcome	At the conclusion of this course, the students will have an understanding of: 1. Fundamental theory of dynamic equation of motion 2. Fundamental analysis methods for dynamic systems 3. Dynamic properties and behaviour of civil structures		

	4. Modelling approach of dynamic response in civil engineering applications	
Prerequisite	Introduction to Solid Mechanics (CE(ES)402), Structural Analysis – I (CE(PC)503), Structural Analysis – II (CE(PE)602B), and Engineering Mathematics (Differential Equation)	
Module 1	**Basics of Structural Dynamics:** Introduction of Structural Dynamics, Differential Equations in Civil Engineering, Types of Analysis/Static and Dynamic load, Degrees of Freedom (Ex: Generation of Stiffness matrix), Dynamic Equilibrium Equation.	3L+2T
Module 2	**Free Vibration of SDOF:** Undamped free Vibration, Natural Period/Frequency, Energy in Free Vibration, Damped Free Vibration, Types of damping, Logarithmic decrement equation **Forced Vibration of SDOF:** Undamped Forced vibration, Amplitude & Phase Angle, Dynamic amplification factor for deflection (Rd), Damped Forced vibration, Relationship between Rd, Rv and Ra	8L+4T
Module 3	**Force Transmission, Vibration Measurement**: Resonant frequency and Half power band width, Force Transmission and Isolation, Design of Vibration Measuring Instruments	3L+1T
Module 4	**Response to Arbitrary Motions:** Response to Unit Impulse, : Response to Arbitrary Force (Duhamel's Integral), Response to Step and Ramp Forces, Response to Rectangular Pulse, Half Sinusoidal wave	2L
Module 5	**Numerical Methods of Solution**: Time Stepping Methods, Central Difference Method, Newmark's Method	2L
Module 6	**Response Spectrum**: Concept of Response Spectrum, Uses of Response Spectrum, Special Cases in Spectrum, Development of Tripartite Plot, :Example: Base Shear and Base Moment, Response of Structure in Frequency Domain	3L+2T
Module 7	**Multi-Degree of Freedom Systems**: Equation of Motion for MDOF System, Solution of Equation, Natural Frequencies and mode Shapes (60), Modal Orthogonality, Approximate Method for finding Natural frequency.	2L+1T
Module 8	**Earthquake Response of MDOF Systems:** Time History Analysis, Response Spectrum Analysis, 3D Dynamic Analysis	2L
Module 9	**Dynamic Response of Continuous Systems**: Vibration of Continuous systems, Shear behaviour and bending behaviour, Generalized SDOF	2L
Module 10	**Dynamics of Rigid Blocks**: Dynamics of Rigid Blocks, Non Structural Elements, : Floor Response Spectrum	2L
Module 11	**Vibration Control**: : Introduction to Vibration Control, Active Control, Passive Control, Design of Tuned Mass Damper	2L+1T

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Structural Dynamics (Theory and Computation)	Mario Paz.	CBS Publishers
	2	Dynamics of Structure (Theory and Application to Earthquake Engineering)	A.K.Chopra	Pearson Education
	3	Dynamics of Structures	Ashok K. Jain	Pearson Education

CE(PE)704B	**Advanced Structural Analysis**	2L + 1T	3 Credits
Course Outcome	After going through this course, the students will be able to: 1. Basic Knowledge of the student will increase. 2. Student will be able to apply stiffness and flexibility method using system approach. 3. Student will understand the yield conditions from their knowledge of stress-strain relations. 4. Student will be able to solve simple plate and shell problems		
Prerequisite	Introduction to Solid Mechanics (CE(ES)402), Structural Analysis – I (CE(PC)503), Structural Analysis – II (CE(PE)602B)		
Module 1	**Matrix methods of structural analysis:** Application of matrix methods to plane truss, beams, continuous frames		9L+5T
Module 2	**Finite difference and relaxation technique**-application to simple problems.		6L+3T
Module 3	**Theory of plate bending**: Navier's Sol utions. Levy's solution. Plate buckling problem. Membrane theory of domes and cylindrical shells.		7L+3T
Module 4	**Theory of Elasticity:** Three dimensional stress and strain analysis, stress strain transformation, stress invariants, equllibrium and compatibility equations. Two dimensional problems in Cartesian and polar coordinates. Plane stress, plane stain problems, St. Venant's principle		6L+1T

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Matrix, finite element, computer and	Mukhopadhyay	ANE Books

		structural analysis,		
	2	Intermediate Structural analysis	Wang	McGrawHill
	3	Theory of Plates and Shells	Timoshenko & Krieger	McGrawHill
	4	Theory of Elasticty	Timoshenko & Goodier	McGrawHill
	5	Analysis of Structures	T.S. Thandavamoorthy	Oxford University Press

CE(PE)704C	**Coastal Hydraulics and Sediment Transport**			2L + 1T	3 Credits
Course Outcome	On successful completion of this course, student should be able to: 1. Explain and quantify coastal wave processes including wave generation, propagation, refraction, shoaling, diffraction, and breaking. 2. Explain and quantify coastal wave properties important to coastal engineering, including wave heights, speeds, induced water velocities, pressures, making appropriate approximations for deep and shallow waters. 3. Characterize and quantify basic coastal sediment transport processes and rates 4. Analyse coastal sites to determine design waves by utilizing historical and bathymetric data. Estimate hydrodynamic forces on coastal structures				
Prerequisite	Introduction to Civil Engineering CE(HS)302, Introduction to Fluid Mechanics CE(ES)401, Water Resources Engineering CE(PC)603,				
Module 1	**Introduction:** Basic understanding of wave mechanics including wave generation, propagation, form and assessment in the coastal zone. Statistical and spectral analysis of recorded wave data and prediction in coastal zone.				6L
Module 2	**Tides and currents:** The equilibrium tide, Dynamic modifications of the equilibrium tide, Modification of tidal pattern, Tidal streams, Tidal bores.				6L
Module 3:	**Waves:** The linear theory of waves, Waves of finite height, Wind waves, Waves in shoaling water, Refraction of waves, Reflection of waves, Diffraction of waves, Oscillations in a harbour, Ship waves.				8L
Module 4:	**Sediment Transport:** Basic concepts, Transport modes, Material in suspension, Bed-Load, Turbidity and density currents, Banks and channels in river estuaries, Regime of the sea-bed; Vertical distribution of suspended sediment in waves and current over a plane bed.				8L
Module 5:	**Littoral drift:** Definition of limit for littoral drift, The effect of grain size, The beach profile, Longshore transport of material, Coastal features.				8L
Module 6:	**Coastal Structures:** Types and use; Effect of construction of coastal structures on stability of shoreline/ beaches, shoreline configuration.				6L
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**	
	1	Coastal hydrodynamics	J. S. Mani	Prentice-Hall of India Ltd, 2012	
	2	Advances in Coastal Hydraulics	V. Panchang, J. Kaihatu	World Scientific Publishing Company, 2018	
	3	Basic Coastal Engineering	R. M. Sorensen	Springer, 2010	
	4	Computational Modeling in Hydraulic and Costal Engineering	C. Kouttias and P. D. Scarlatos	CRC Press, 2016.	

CE(PE)705A	**Railway and Airport Engineering**	2L + 0T	2 Credits
Course Outcome	Students will be able to **6.** Explain the basics in planning functional components of Railway and Airport. **7.** Illustrate the engineering concepts of construction, operation and maintenance of Railway and Airport components. **8.** Interpret the geometric design parameters of Railway **9.** Decide the runway orientation of proposed runway on the basis of previous wind data analysis **10.** Assess the basic runway length parameters.		
Prerequisite	Class-XII level knowledge of Physics, Mathematics.; Undergraduate level knowledge of Strength of Materials.		
Module 1	**Railway Engineering** Introduction to Railway Engineering: Socio-economic impact of Indian Railways; Zonal classification of Indian Railways; Railway track gauge; Classification of Indian Railways based on Speed Criteria.		20L

	Permanent Way (P-way): Components – Rails, Rail joints, Sleepers, Ballast, Fastenings, Sub-grade. Track Alignment and Engineering Survey: Basic requirement of good alignment; Factors in selection of good alignment; Engineering Survey. Track Stresses; Geometric Design: Gradient, Speed, Degree of Curve, Super-elevation, Transition curve, Widening of gauge on curves, Shift. Points and Crossings; Station and Yards; Signalling and Control Systems.	
Module 2	**Airport Engineering** Airport Site Selection; Airport layout;Functions and planning of the Airfield components – runway, taxiway and Aprons, hanger, terminal building and control tower; Design of Runway and Taxiway; Runway orientation: Windrose diagrams.	10L

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	A Textbook of Railway Engineering	Saxena S.P. & Arora S.P	Dhanpat Rai & Sons
	2	Indian Railway Track	Agarwal M.M	Sachdeva Press
	3	Airport Planning & Design	KhannaS.K , Arora M.G & Jain S.S	Nemchand Brothers
	4	Planning & Design of Airports	Horonjeff R &Mckelvey F	Mc. Graw Hill.

CE(PE)705B	**Pavement Design**	2L + 0T	2 Credits
Course Outcome	At the end of the course, the student will be able to: 1. Differentiate between different types of pavements, both structurally and functionally. 2. Conduct Axle Load Survey and Estimate Design Traffic. 3. Analyze and design bituminous and cement concrete pavement using. 4. Understand the principles of Pavement Maintenance and identify various pavement distresses.		
Prerequisite	Transportation Engineering (CE(PC)506)		
Module 1	**Pavement Design** Flexible Pavement Design: Stresses and Deflections in homogeneous masses.; Burmister's two layer theory; Three layer and multi-layer theories; wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels; McLeod method of design; AASTHO method of flexible pavement design. Low Volume Rigid Pavement: Criteria of Load, Scope and Specifications as per different Govt policies in India, Design Criteria.		13L
Module 2	**Pavement Construction and Management** Flexible Pavement Construction: Earthwork (Method of Alignment-wise marking using chainage), compaction of embankments, construction methods and field control checks for various types of flexible pavement materials in sub-base, base, binder and surface course layers; Construction procedure of Low Volume Rigid Pavement.		9L
Module 3	**Pavement Evaluation - Pavement Distress** Functional condition evaluation of pavements- Roughness, Skid Resistance, Serviceability Index; Structural evaluation of pavements –Benkelman beam and Falling Weight Deflectometer; Pavement strengthening; Design of bituminous and concrete overlays as per IRC		8L

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Principles of Pavement Design	E. J. Yoder & M.W. Witzack	John Wiley and Sons
	2	Pavement Analysis and Design	Yang H. Huang	Pearson
	3	Principles of Transportation Engineering	P. Chakraborty & A. Das	PHI
	4	Highway Engineering	Khanna& Justo	Nemchand& Brothers
	5	Relevant latest IRC Codes (IRC-37 – 2001, IRC-37 – 2012, IRC 58 – 2015, IRC 81 -1997-		

		Indian Road Congress

CE(PE)705C	**Transportation System Planning**	2L + 0T	2 Credits
Prerequisite	Transportation Engineering (CE(PC)506)		
Module 1	**Introduction** Importance of transportation, transportation planning methodology, hierarchical levels of planning and its relation to rural, urban areas. Long range planning, Passenger and goods transportation, General concept and process of transport planning, Land-use transport interactions, Socio-economic characteristics of Land use		5L
Module 2	**Transportation System** Multi modal transportation system; Characteristics of Mass Transit systems including technical, demand operational and economic problems, fixed Track Facility, Mass Rapid Transit System Elevated, Surface and Underground construction , integrated Operating Characteristics of Terminal and Transfer facilities		10L
Module 3	**Transport planning** Studies: Urban Travel Characteristics, Private and Public Behaviour analysis, Transportation demand Surveys, Delineation of the urban area, zoning, Origin-Destination Studies, Home Interviews, trip Classification. Methodology: Study of existing network-trip generation techniques, Category analysis, multiple regression techniques, Modal split analysis, Trip distribution techniques, Growth Factor model, Gravity models, Opportunity models and multiple regression models.		15L

Semester VIII [Fourth year]

CE(HS)801A	**Professional Practice, law & Ethics**	2L	2 Credits
Module 1	**Professional Practice** – Respective roles of various stakeholders: Government(constituting regulatory bodies and standardization organizations, prescribing norms to ensure safety of the citizens); Standardization Bodies (ex. BIS, IRC)(formulating standards of practice);professional bodies (ex. Institution of Engineers(India), Indian Roads Congress, IIA/COA, ECI, Local Bodies/ Planning Authorities) (certifying professionals and offering platforms for interaction);Clients/ owners (role governed by contracts); Developers (role governed by regulations such asRERA); Consultants (role governed by bodies such as CEAI); Contractors (role governed by contracts and regulatory Acts and Standards); Manufacturers/ Vendors/ Service agencies (rolegoverned by contracts and regulatory Acts and Standards) **Professional Ethics** – Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website of Institution of Engineers (India); Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistleblowing, protected disclosures.		4L
Module 2	General Principles of Contracts Management: Indian Contract Act, 1972 and amendments covering General principles of contracting; Contract Formation & Law; Privacy of contract; Various types of contract and their features; Valid & Voidable Contracts; Prime and subcontracts; Joint Ventures & Consortium; Complex contract terminology; Tenders, Request For Proposals, Bids & Proposals; Bid Evaluation; Contract Conditions & Specifications; Critical /"Red Flag" conditions; Contract award & Notice To Proceed; Variations & Changes in Contracts; Differing site conditions; Cost escalation; Delays, Suspensions & Terminations; Time extensions &Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation; Performance and Excusable Non-performance; Contract documentation; Contract Notices; Wrong practices in contracting (Bid shopping, Bid fixing, Cartels); Reverse auction; Case Studies; Build-Own-Operate & variations; Public- Private Partnerships; International Commercial Terms;		18L

Module 3:	Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system: Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996; UNCITRAL model law –Arbitration and expert determination; Extent of judicial intervention; International commercial arbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for setting aside an award, Enforcement, Appeal and Revision; Enforcement of foreign awards – New York and Geneva Convention Awards; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats.	5L
Module 4:	Engagement of Labour and Labour & other construction-related Laws: Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, piece rate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act,1946; Workmen's Compensation Act, 1923; Building & Other Construction Workers (regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017	2L
Module 5:	Law relating to Intellectual property: Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India, Patentable inventions with special reference to biotechnology products, Patent protection for computer programs, Process of obtaining patent – application, examination, opposition and sealing of patents, Patent cooperation treaty and grounds for opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies;	1L

	Sl.	Book Name	Author	Publishing House
Reference	1	Legal Aspects of Building and Engineering Contracts	B.S. Patil	
	2	The National Building Code	BIS	
	3	Indian Contract Act	Dutta	Eastern Law House
	4	The Arbitration & Conciliation of Law in India with case law on UNCITRALModel Law on Arbitration	Kwatra G.K.	Indian Council of Arbitration

CE(PE)801A	**GIS & Remote Sensing**	2L	2 Credits
Course Outcome	Upon completing the course, the students will be able to: **14.** Define and state the scope GIS & remote sensing in civil engineering **15.** Understand the basic principles of remote sensing and GIS **16.** Apply the various methods of remote sensing and GIS to different geospatial datasets **17.** Analyze the different results obtained from different remote sensing data sources **18.** Evaluate the different results in solving real world problems. **19.** Design and construct optimum solutions for real world problems that can be resolved by GIS & remote sensing		
Prerequisite	Knowledge of Class-XII level physics, computer science Knowledge of CE(PC)404 and CE(PC)494		
Module 1	**Fundamentals of Remote Sensing:** Energy sources and radiation principles; Electromagnetic Spectrum; Energy interactions in the atmosphere and with earth surface features; Atmospheric windows; Spectral response patterns and spectral signatures		3L
Module 2	**Digital Image Processing:** Image rectification and restoration; Image enhancement; Image classification; Accuracy assessment; Digital change detection; Spatial, spectral, radiometric and temporal resolution characteristics of IRS, Landsat and Sentinel data.		6L
Module 3:	**Advanced Remote Sensing**: Microwave remote sensing: Frequency and wavelengths, polarization, range and azimuth resolution, relief displacement, foreshortening, layover, shadows and speckles; Synthetic Aperture Radar (SAR); Indian microwave sensors; Working principles of LiDAR remote sensing		3L
Module 4:	**Advanced Digital Image Processing**:		3L

	Principal Component Analysis (PCA); Colour Space Transformation; Fourier Transformation; Image fusion; Hybrid classification system	
Module 5:	**GIS**: Definition, components and applications of GIS; Spatial and attribute data; Raster vs. Vector GIS; Concept of topology; Non-topological data structures	3L
Module 6	**Database and Coordinate System**: Concepts of Relational Data Base Management System (RDBMS) and geodatabase; Spatial and attribute query; Datum and projection; Universal Transverse Mercator (UTM) grid system; On-the-fly projection	3L
Module 7	**Spatial Data Analysis**: Concepts of local, focal, zonal and global analysis; Proximity analysis; Distance measurement; Raster and vector overlay; Spatial interpolation; DEM and TIN, Cost surface analysis	6L
Module 8	**Applications of GIS & Remote Sensing**: Watershed analysis; Runoff and erosion modelling, Location and allocation analysis; Atmospheric pollution monitoring; Urban growth modelling; Carbon sequestration and climate change	5L

	Sl.	Book Name	Author	Publishing House
Reference	1	Remote Sensing and Image Interpretation	Thomas M. Lillesand Ralph W. Kiefer Jonathan W. Chipman	Wiley India Edition
	2	Introduction to Geographic Information Systems	Kang-tsung Chang	Tata McGraw-Hill Publishing Company Limited
	3	Remote Sensing and GIS	Basudeb Bhatta	Oxford University Press
	4	Remote Sensing of Environment: An Earth Resource Perspective	J. R. Jensen	Pearson
	5	Applications of Geomatics in Civil Engineering	J. K. Ghosh I. de Silva (Eds.)	Springer
	6	Introductory Digital Image Processing: A Remote Sensing Perspective	J. R. Jensen	Pearson
	7	Concepts and Techniques of Geographic Information Systems	C. P. Lo A. K. W. Yeung	Pearson

CE(PE)801B	**Rock Mechanics**	2L	2 Credits
Module 1	Composition of rocks, Engineering classification and Limitation of Geologic classification of rocks		4L
Module 2	Rock coming, various methods of obtaining rock cores, Engineering Properties of rock, stress -strain relations, elastic theory application to design in rock.		6L
Module 3:	Strength and failure of rocks, Uniaxial and triaxial strength of rocks, failure theories of rocks and propagation of cracks, Griffith Chack theory -Water in rock, Structural feature of mass rocks and their effects on engineering properties.		8L
Module 4:	Measurement of stresses -rock mass, various types of measuring devices, evaluation of properties of rocks in the field.		6L
Module 5:	Strain and displacement of the rock mass, rock reinforcement and support, subsidence.		6L

	Sl.	Book Name	Author	Publishing House
Reference	1	Engineering Rock Mechanics: An Introduction to the Principles	J. A. Hudson and J. P. Harrison	
	2	Rock Mechanics: For Underground Mining	Barry H.G.	
	3	Empirical Rock Failure Criteria	P.R. Sheorey, Balkema, Rotterdam	
	4	Rock Mechanics in Engineering Practice	K.G.Stagg and O.C.Zienkiewicz,	John Wiley and Sons
	5	Hand Book on Mechanical Properties of Rocks	V.S. Vutukuri and R D Lama	
	6	Rock Mechanics for Engineers	B.P Verma	
	7	Engineering Behavior of Rocks	W. Farmer,	Chapman and Hall Ltd

CE(PE)801C	Environmental Laws and Policy	2L	2 Credits
Course Outcome	Upon completing the course, the students will be able to: **1.** To apply the relevant measures to mitigate pollution from different sources. **2.** To understand the effects of the various pollutants on the environment as a whole according to the formulated guidelines **3.** To be able to give recommendations for alternatives to reduce pollution **4.** To formulate standards of the various parameters corresponding to their impact on the environment with changing time		
Prerequisite	Basic Science, Biology, Environmental Sciences and Environmental Engineering (Including Air Quality Dispersion, Meteorology, Solid Waste Management, EIA)		
Module 1	**Introduction:** Environment, Nature, Ecosystem, Origin of Environmental laws, Concept of laws and policies, Environment and Governance		3L
Module 2	**Sustainable Development and Environment:** Understanding of Climate change Concept of Carbon Footprint, Carbon Credit, Carbon Offsetting Use of Hybrid Energy (Conventional +Non Conventional) Use of Clean Development Mechanism		6L
Module 3:	**Environmental Laws (Indian Perspective) :** Indian Environmental Laws and Policies		8L
Module 4:	**Environmental Laws (International Perspective) :** Fundamental Principles and Application of International Environmental Law, Introduction to Trade and Environment Right to Environment as Human Right International Humanitarian Law and Environment Environment and Conflict Management Focus on International Protocols- UNFCCC & Kyoto Protocol, Treaty on Antarctic & Polar Regions, UN Conventions of Law of the Sea and Regional Sea Convention, Law on International Water Courses		11L

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Environmental Law and Policy	Aruna Venkat.	PHI Publication.
	2	Environmental Law and Policy	James Salzuman & Burton H. Thompson (Jr.),	Foundation Press.
	3	Environmental Law	Gurdip Singh	Eastern Book Company
	4	Climate Change, Law, Policy and Governance	Usha Tandon	Eastern Book Company.

CE(PE)801D	Pavement Materials	2L	2 Credits
Module 1	**Introduction** Basic road construction materials : Types of basic materials, Suitability of different materials depends on their availability and characteristics, Economic, Environmental, and Social issues of material usage, Life cycle analysis and its use in design		3L
Module 2	**Soil** Classification; Index & Engineering properties of soil, Properties of sub-grade; Suitability of different type of soil for the construction of highway embankments and pavement layers; Field compaction and control. Introduction to Soil Stabilization: Physical and Chemical modification: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. A critical look at the different laboratory and in-situ procedures for evaluating the mechanical properties of soils viz. CBR, Plate Load test, resilient modulus, DCPT		7L
Module 3:	**Aggregate** Characterization: Origin, classification, properties. Tests and specifications on road aggregates for flexible and rigid pavements. Importance of aggregate gradation problems on Rothfutch's and Critical sieve methods and Shape factor in mix design		6L
Module 4:	**Bitumen Binders** Different types, properties and uses, Tests on bitumen, Rheological and pavement performance related properties, Criteria for selection of different binders. Marshall Method of mix design, Additives & Modifiers in Bituminous		6L

	mixes, problems on mix design			
Module 5:	**Cement** Requirements, design of mix for CC pavement, use of additives, IRC specifications & Tests, joint filler and sealer materials.			3L
Module 6:	**Modern trend of using Modified, Sustainable and Environment friendly materials** Geo-Synthetics: Geo-synthetic clay liner – Construction details – Geo Synthetic Materials – Functions – Property characterization Modified bitumen: Crumb Rubber Modified bitumen, Natural rubber modified bitumen, polymer modified bitumen; Long term and short term ageing and its effect on bitumen performance Plastic waste: Types of polymer, applicability of polymer based waste product in different layers of pavement			4L
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Highway Engineering	Khanna and Justo	Nem Chand and Bros.
IS and IRC codes	1	IS 73, revised 2006, IS 2720, IS 2386, IS 1201 to 1220, IS 8887- 1995, IS 217- 1986		
	2	IRC: 51-1992, 63-1976, 74 –1979, 88-1984,		
	3	IRC SP: 53 – 2002, IRC SP: 58 – 2000,		
	4	"Guidelines for use of Geotextiles in Road Pavements and Associated works"- 2002; IRC		
	5	State of art, special report 3 – "compaction of earthwork and subrade"- IRC, HRB, 1999		
	6	MoRTH 'Specifications for Roads and Bridges Works'- Indian Roads Congress		

CE(OE)801A	**Human Resource Development and Organizational Behaviour**	2L		2 Credits
Module 1	**Organizational Behaviour:** Definition, Importance, Historical Background, Fundamental Concepts of OB, Challenges and Opportunities for OB			2L
Module 2	**Personality and Attitudes:** Meaning of personality, Personality Determinants and Traits, Development of Personality, Types of Attitudes, Job Satisfaction			2L
Module 3:	**Perception:** Definition, Nature and Importance, Factors influencing Perception, Perceptual Selectivity, Link between Perception and Decision Making.			2L
Module 4:	**Motivation:** Definition, Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Y, Herzberg's Motivation-Hygiene Theory, Alderfer's ERG Theory, McClelland's Theory of Needs, Vroom's Expectancy Theory.			4L
Module 5	**Group Behaviour**: Characteristics of Group, Types of Groups, Stages of Group Development, Group Decision Making.			2L
Module 6	**Communication:** Communication Process, Direction of Communication, Barriers to Effective Communication			2L
Module 7:	**Leadership:** Definition, Importance, Theories of Leadership Styles			2L
Module 8:	**Organizational Politics:** Definition, Factors contributing to Political Behaviour.			2L
Module 9:	**Conflict Management:** Traditional vis-a-vis Modern View of Conflict, Functional and Dysfunctional Conflict, Conflict Process, Negotiation – Bargaining Strategies, Negotiation Process.			3L
Module 10:	**Organizational Design:** Various Organizational Structures and their Effects on Human Behaviour, Concepts of Organizational Climate and Organizational Culture.			4L
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Organizational Behavior	Robbins, S. P. & Judge, T.A	Pearson
	2	Organizational Behavior	Luthans, Fred	McGraw Hil
	3	Understanding Organizations – Organizational Theory & Practice in India	Shukla, Madhuka	PHI
	4	Principles of Organizational	Fincham, R. & Rhodes, P	Oxford University Press

		Behaviour		

CE(OE)801B	**Bridge Engineering**			2L	2 Credits
Course Outcome	After going through this course, the students will be able to: 1. Discuss basic definitions, types, and components of bridges. 2. Discuss sub-surface investigations required for bridge construction. 3. Understand standard specification and loads for bride design. 4. Perform design of different types bearings and joints for bridges. 5. Perform design of various reinforced concrete and steel bridges.				
Prerequisite	Design of RC Structures (CE(PC)501), Structural Analysis – I (CE(PC)503), Design of Steel Structures (CE(PC)604),				
Module 1	**Introduction:** Definition and basic forms, components of a typical bridge, classification of bridges, site investigation, bridge hydrology and hydraulics. **Loads:** I.R.C loads, impact factors, wind loads, longitudinal forces, lateral forces and centrifugal forces. **Bearings:** Types of bearings, details of bearing, joints, design examples				3L
Module 2	**Design of reinforced concrete solid slab bridge:** Introduction, general design features, economic span, effective width method, simply supported and cantilever slab bridges, analysis and design.				7L
Module 3	**Design of box culvert bridge:** Introduction, design method and design example.				4L
Module 4	**Design of a T beam bridge:** Introduction, components, design of interior panel of slab, longitudinal and cross girders, Pigeaud's method, design example.				6L
Module 5	Design of composite bridge: General aspects, method of construction, analysis of composite section, shear connectors, design of composite beam.				4L
Module 6	**Design of steel bridges:** General features, types of stress, design of railway truss bridge and plate girder bridge				6L
Module 7	**Design of cable stayed bridge:** General features, Philosophy of design.				2L
IS Codes	**1**	All relevant IRC and IS codes			
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**	
	1	Prestressed Concrete Bridges	N. Krishnaraju	CBS Publisher	
	2	Design of Bridge Structures	Jagadish and Jayaram	PHI	
	3	Essential Bridge Engineering	Jhonson Victor D.	Oxford, IBH Publishing Co.	
	4	Design of Bridges	N. Krishnaraju	Oxford, IBH Publishing Co.	
	5	Concrete Structures	Vazirani & Ratwani	Khanna Publishers	
	6	Design of concrete bridges	Aswani, Vazirani & Ratwani	Khanna Publishers	
	7	Bridge engineering	Ponnuswamy	McGrawHill	
	8	Principle & Practice of Bridge Engineering	Bindra	Dhanpat Rai Publishing House	

CE(OE)801C	**Deep Foundations**		2L + 0T	2 Credits
Course Outcome	On successful completion of this course, student should be able to: 11. Explain the concept of bearing capacity for deep foundation. 12. Estimate the safe bearing capacity including settlement consideration for deep foundations. 13. Select a suitable deep foundation system for various site conditions and also analysis of that. 14. Explain in what circumstances pile is needed and how to estimate pile and pile group capacity under various soil conditions Characterize.			
Prerequisite	Introduction to Civil Engineering CE(HS)302, CE(PE)601 Foundation Engineering, Soil Mechanics – II CE(PC)504, Soil Mechanics – I CE(PC)401.			
Module 1	**Piles:** types - load carrying capacity of pile - static and dynamic formula - pile load test - penetration test - pile groups - Efficiency - Feld's rule –Converse Labarre formula, Settlement of piles and pile groups - Negative skin friction – under-reamed piles, pile cap			10L
Module 2	**Drilled Pier:** Introduction, uses, types, bearing capacity, settlement, construction procedures.			6L
Module 3:	**Cassion foundations:** Types & selections, forces & moments, depth determination.			4L
Module 4:	**Well foundations:** The Types, components, design of well foundations – grip, size, steining, curb, cutting edge, top & bottom plug, well cap; stability analysis of			8L

	well foundation, construction, shift & tilts.			
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Principles of Foundation Engineering	Braja M. Das	Thomson Asia Pvt. Ltd., Singapore, 2005.
	2	Geotechnical Engineering, Principles and Practices,	Donald P. Coduto, Man-Chu Ronald Yeung and William A. Kitch,	PHI Learning Private limited, 2011.
	3	Soil Mechanics and Foundation Engineering	P. Purushothama Raj	Pearson publication

CE(OE)801D	**Groundwater Contamination**	2L + 0T	2 Credits
Course Outcome	On successful completion of this course, student should be able to: 1. To be able to understand the principles and theories regarding groundwater contamination with 2. To be able to formulate the various remedial measures for groundwater contamination		
Prerequisite	Basic Sciences, Hydrology, Meteorology and Groundwater Hydrology		
Module 1	**Introduction:** Definition of groundwater, hydrological properties of various water bearing strata, vertical distribution of subsurface water, groundwater in hydrologic cycle		2L
Module 2	**Groundwater Hydraulics:** Darcy's Law, Dupuit's assumption, Application of Darcy's Law for simple flow systems, Governing differential equations for confined and unconfined aquifers, steady and unsteady flow solutions for fully penetrating wells, partially penetrating wells, Interference of wells, Test pumping analysis with steady and unsteady flows, Delayed yield, method of images		7L
Module 3:	**Groundwater quality:** Indian & International standards		3L
Module 4:	**Groundwater pollution:** Sources, Remedial and preventive measures		3L
Module 5:	**Groundwater conservation:** Groundwater budget, seepage from surface water, artificial recharge with reclamation		3L
Module 6:	**Models for Groundwater flow:** Sampling & Monitoring methods, transport mechanisms, modeling (advective and dispersive transport), (adsorption and chemical reaction), biodegradation kinetics, numerical flow and transport modeling, waste site characterization/investigation, groundwater remediation, legal issues in groundwater contamination		10L

Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Elements of Hydrology and Groundwater	R.N. Saxena & D.C. Gupta	PHI
	2	Groundwater Contamination, Performance, Limitations and Impacts	Anna L Powell	Nova Science Publishers
	3	Groundwater Contamination and Remediation	Edited by Timothy D. Scheibe & David C. Mays	MDPI

CE(OE)802A	**Soft Skills and Personality Development**	2L	2 Credits
Module 1	**Self-Growth** i)Self Growth- Maslow's Hierarchy of Needs Theory ii) Anger, Stress & Time Management- Theories and application iii) SWOT Analysis		6L
Module 2	**Stepping Up** i) Growth & Environment ii) Competitive Spirit iii) Responsibility Factor		7L
Module 3:	**Professional Communication** i) Impression Management- theory on social psychology ii) Employability Quotient iii) Cross-cultural communication		6L
Module 4:	**Leadership & Team Playing** i) Leadership & Team Playing: Theories, Styles, Stages ii) Motivation,		6L

	Negotiation Skills, Conflict Management iii) Planning & Envisioning: Initiative and Innovation in the Work Environment- De Bono's Six Thinking Hats			
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Personality Development and Soft Skills	Barun K. Mitra	Oxford University
	2	Soft Skills: An Integrated Approach to Maxmise Personality	Gajendra Singh Chauhan and Sangeeta Sharma	Wiley
	3	The Ace of Soft Skills: Attitude, Communication and Etiquette for Success	Gopalaswamy Ramesh and Mahadevan Ramesh	Pearson

CE(OE)802B	**Earthquake Engineering**	2L	2 Credits
Course Outcome	After going through this course, the students will be able to: **1.**To provide a coherent development to the students for the courses in sector of earthquake engineering. **2.**To present the foundations of many basic engineering concepts related earthquake Engineering **3.**To give an experience in the implementation of engineering concepts which are applied in field of earthquake engineering **4.**To involve the application of scientific and technological principles of planning, analysis, design of buildings according to earthquake design philosophy.		
Prerequisite	Introduction to Solid Mechanics (CE(ES)402), Structural Analysis – I (CE(PC)503), Structural Analysis – II (CE(PE)602B), Design of RC Structures (CE(PC)501), Structural Dynamics (CE(PE)704A).		
Module 1	**Seismology:** Earth's Interior and Plate Tectonics; Causes of Earthquakes and Seismic Waves; Measurement of Earthquakes and Measurement parameters; Modification of Earthquake due to the Nature of Soil; Seismic Hazard Analysis		4L
Module 2	**Earthquake Inputs:** Time History Records and Frequency Contents of Ground Motion; Power Spectral Density Function of Ground Motion; Concept of Response Spectrums of Earthquake; Combined D□V□A Spectrum and Construction of Design Spectrum; Site Specific, Probabilistic and Uniform Hazard Spectrums; Predictive Relationships for earthquake parameters;		4L
Module 3	**Dynamics for Earthquake Analysis:** Equations of Motion for SDOF and MDOF Systems; Undamped Free Vibration of SDOF and MDOF Systems; Mode Shapes and Frequencies of MDOF System; Rayleigh Damping Matrix; Direct Time Domain Analysis of MDOF System; Direct Frequency Domain Analysis of MDOF System; Modal Analysis in Time and Frequency Domain		4L
Module 4	**Response Analysis for Specific Ground Motion**: Equations of Motion for Single and Multi□ Support Excitations and Solutions; Equations of Motion in State Space and Solutions; Computational Steps for the Solutions using MATLAB; Time History Analysis of 3D Tall Buildings.		4L
Module 5	**Response Spectrum Method of Analysis:** Concept of Equivalent Lateral Force for Earthquake; Modal Combination Rules; Response Spectrum Method of Analysis of Structures and Codal Provisions; Response Spectrum Method of Analysis for Torsionally Coupled Systems; Response Spectrum Method of Analysis for Non□Classically Damped Systems;		4L
Module 6	**Seismic Soil - Structure Interaction:** Fundamentals of Seismic Soil□ Structure Interaction; Direct Method of Analysis of Soil□Structure 6 Interaction using FEM and Use of ABAQUS, Substructuring Method of Analysis of Soil□ Structure Interaction Problem		4L
Module 7	**Inelastic Response of Structures for Earthquake Forces:** Fundamental Concepts of Inelastic Response Analysis for Earthquake Forces; Solutions of Incremental Equations of Motions for SDOF Systems; Solutions of Incremental Equations of Motions for MDOF Systems; Push over Analysis; Concepts of Ductility and Inelastic Spectrum;		5L
Module 8	**Base isolation for earthquake resistant design of structures:** Base isolation concept, isolation systems and their modelling; linear theory of base isolation; stability of elastomeric bearings; codal provisions for seismic isolation, practical applications.		5L

IS Codes	1	IS1893: Part I (2016),		
	2	IS 13920: 2016		
	3	IS 4326		
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Earthquake resistant design	Agarwal and Shrikhande	PHI

		of Structures		
	2	Earthquake-resistant design of structures	S.K. Duggal,	Oxford University Press.
	3	Elements of Eathquake Engineering	Jai Krishna, A. R. Chandrashekhar and Brijesh Chandra	South Asian Publishers
	4	Earthquake Resistant Design	D. J. Dowrick	John Willey & Sons

CE(OE)802C	**Urban Transport Planning**	2L	2 Credits
Module 1	**Introduction** Urban morphology - Urbanization and travel demand – Urban activity systems and travel patterns – Systems approach – Trip based and Activity based approach		4L
Module 2	**Urban Transportation Planning** Goals, Objectives and Constraints - Inventory, Model building, Forecasting and Evaluation - Study area delineation – Zoning - UTP survey. Trip generation models – Trip classification - productions and attractions – Trip rate analysis - Multiple regression models - Category analysis. Trip distribution models – Growth factor models, Gravity model and Opportunity modes. Modal split models – Mode choice behavior – Trip end and trip interchange models - Probabilistic models – Utility functions - Logit models - Two stage model. Traffic assignment – Transportation networks – Minimum Path Algorithms - Assignment methods – All or Nothing assignment, Capacity restrained assignment and Multi path assignment - Route-choice behavior.		21L
Module 3	**Scope of UTP in present scenario** Financing of Project – urban development planning policy - Case studies.		5L

Reference	**Sl.**	**Book Name**	**Author**
	1	Traffic Engineering and Transport Planning	L R Kadiyali
	2	Urban Transportation: Planning, Operation and Management	S Ponnuswamy and Johnson Victor
	3	Transportation Planning: Principles, Practices and Policies	Pradeep Kumar Sarkar and Vinay Maitri

CE(OE)802D	**Environmental Impact Assessment and Life Cycle Analyses**	2L	2 Credits
Course Outcome	After going through this course, the students will be able to: **1.** To understand and evaluate the impact of any activity (large or small scale) on the surrounding environment **2.** To be able to formulate mitigation strategies to protect the environment leading to sustainability **3.** To be able to understand the intricacies of Life Cycle Analysis and apply basic knowledge for coherent existence		
Prerequisite	Basic Sciences, Biology, Environmental Science and Environmental Engineering		
Module 1	**Introduction** Definition, Objective with legal aspect of Environmental Impact Assessment (EIA)		2L
Module 2	**Methodology** for EIA with Base Line Studies, Screening , Scoping and Public Consultation		4L
Module 3	**EIA Analysis** Data Collection & Environmental Impact Analysis, preparation of EIA report		5L
Module 4	**EIA Mitigation and Audit**- Mitigation and Impact Management with various case studies, Environmental Audit		5L
Module 5	**Introduction to Life Cycle Analysis (LCA):** History, Definition, Standards and structure of LCA Goal and Scope of LCA: System of a product with boundary, unit process and functional unit		2L
Module 6	**Life Cycle Interpretation and Inventory:** Limitation of LCA, Identification of significant issues, Evaluation, Reporting, Critical Review. Inventory: Data Collection, Data Bases, Allocation, Validation		3L
Module 7	**LCA Impact Assessment and Practice:**		4L

	Categories, Classification, Normalization, LCA Management, Life Cycle thinking, Sustainability			
Module 8	**Introduction:** Definition, Objective with legal aspect of Environmental Impact Assessment (EIA)			2L
Reference	**Sl.**	**Book Name**	**Author**	**Publishing House**
	1	Environmental Impact Assessment	R. R. Barthwal,	New Age International Publication
	2	Environmental Impact Assessment	Canter	McGraw Hill Publications
	3	Environmental Impact Assessment: Theory and Practice	M. Anji Reddy	B. S. Publication
	4	Environmental Impact Assessment: Theory and Practice	Peter Wathern	CRC Press
	5	Life Cycle Assessment (LCA): A Guide to Best Practice	Walter Klöpffer , Birgit Grahl	Wiley Publishers
	6	Environmental Life Cycle Assessment	Olivier Jolliet, Myriam Saade-Sbeih, Shanna Shaked, Alexandre Jolliet, Pierre Crettaz,	CRC Press
	7	Life Cycle Student Handbook	Mary Ann Curran,	Scrivener Publishing, Wiley