

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)

Curriculum Structure
Semester III (Second year)

Sl. No.	Category	Code	Course Title	Hours per week			Credits
				L	T	P	
Theory							
1	Basic Science courses	CE(BS)301	Biology for Engineers	2	1	0	3
2	Engineering Science Courses	CE(ES)301	Engineering Mechanics	3	1	0	4
3	Engineering Science Courses	CE(ES)302	Energy Science & Engineering	1	1	0	2
4	Basic Science courses	CE(BS)302	Mathematics-III (Transform & Discrete Mathematics)	2	0	0	2
5	Humanities and Social Sciences including Management courses	CE(HS)301	Humanities-I (Effective Technical Communication)	3	0	0	3
6	Humanities and Social Sciences including Management courses	CE(HS)302	Introduction to Civil Engineering	1	1	0	2
Theory credits							16
Practical/ Sessional							
1	Engineering Science Courses	CE(ES)391	Basic Electronics	1	0	2	2
2	Engineering Science Courses	CE(ES)392	Computer-aided Civil Engineering Drawing	1	0	2	2
3	Engineering Science Courses	CE(ES)393	Life Science	1	0	2	2
Practical credits							6
Total credits							22

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Semester IV (Second year)

Sl. No.	Category	Code	Course Title	Hours per week			Credits
				L	T	P	
Theory							
1	Engineering Science Courses	CE(ES)401	Mechanical Engineering	2	1	0	3
2	Professional Core courses	CE(PC)401	Instrumentation & Sensor Technologies for Civil Engineering Applications	1	1	0	2
3	Professional Core courses	CE(PC)403	Introduction to Fluid Mechanics	2	0	0	2
4	Professional Core courses	CE(PC)404	Introduction to Solid Mechanics	2	0	0	2
5	Professional Core courses	CE(PC)405	Surveying & Geomatics	1	1	0	2
6	Professional Core courses	CE(PC)406	Materials, Testing & Evaluation	1	1	0	2
7	Humanities and Social Sciences including Management courses	CE(HS)401	Civil Engineering - Societal & Global Impact	2	0	0	2
8	Mandatory Courses (non-credit)	CE(MC)401	Management I (Organizational Behavior)	3	0	0	0
Theory credits							15
Practical/ Sessional							
1	Professional Core courses	CE(PC)491	Instrumentation & Sensor Technologies for Civil Engineering Applications	0	0	2	1
2	Professional Core courses	CE(PC)492	Engineering Geology	1	0	2	2
3	Professional Core courses	CE(PC)493	Introduction to Fluid Mechanics	0	0	2	1
4	Professional Core courses	CE(PC)494	Surveying & Geomatics	0	0	2	1
5	Professional Core courses	CE(PC)495	Materials, Testing & Evaluation	0	0	2	1
Practical credits							6
Total credits							21

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Semester V (Third year)

Sl. No.	Category	Code	Course Title	Hours per week			Credits
				L	T	P	
Theory							
1	Professional Core courses	CE(PC)501	Mechanics of Materials	3	0	0	3
2	Professional Core courses	CE(PC)502	Hydraulic Engineering	2	0	0	2
3	Professional Core courses	CE(PC)503	Structural Engineering	3	1	0	4
4	Professional Core courses	CE(PC)504	Geotechnical Engineering	2	1	0	3
5	Professional Core courses	CE(PC)505	Environmental Engineering	2	1	0	3
6	Professional Core courses	CE(PC)506	Transportation Engineering	2	0	0	2
7	Mandatory courses (non-credit)	CE(MC)501	Constitution of India/ Essence of Indian Knowledge Tradition	-	-	-	0
Theory credits							17
Practical/ Sessional							
1	Professional core courses	CE(PC)591	Hydraulic Engineering	0	0	2	1
2	Professional core courses	CE(PC)592	Structural Engineering	0	0	2	1
3	Professional core courses	CE(PC)593	Geotechnical Engineering	0	0	2	1
4	Professional core courses	CE(PC)594	Environmental Engineering	0	0	2	1
5	Professional core courses	CE(PC)595	Transportation Engineering	0	0	2	1
Practical credits							5
Total credits							22

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Semester VI (Third year)

Sl. No.	Category	Code	Course Title	Hours per week			Credits
				L	T	P	
Theory							
1	Professional Core courses	CE(PC)601	Construction Engineering & Management	2	1	0	3
2	Professional Core courses	CE(PC)602	Engineering Economics, Estimation & Costing	2	1	0	3
3	Professional Elective courses	CE(PE)601	Elective-I	2	0	0	2
4	Professional Elective courses	CE(PE)602	Elective-II	2	0	0	2
5	Open Elective courses	CE(OE)601	Open Elective-I (Humanities)	1	1	0	2
6	Professional Elective courses	CE(PE)603	Elective-III	2	1	0	3
7	Professional Elective courses	CE(PE)604	Elective-IV	2	0	0	2
Theory credits							17
Practical/ Sessional							
1	Professional Core courses	CE(PC)691	Engineering Economics, Estimation & Costing	0	0	4	2
Practical credits							2
Total credits							19

CE(PE)601(Elective-I)	CE(PE)602(Elective-II)
601A : Geometric Design of Highways 601B : Transport of Water and Wastewater 601C: Structural Analysis-I 601D: Foundation Engineering	602A : Pavement Design 602B : Air and Noise Pollution and Control 602C: Structural Analysis-II 602D: Soil Mechanics-II
CE(PE)603(Elective-III)	CE(PE)604(Elective-IV)
603A: Concrete Technology 603B: Soil Mechanics-I 603C: Solid and Hazardous Waste Management 603D: Geographic Information Systems and Science	604A: Pavement Materials 604B: Design of Concrete Structures-I 604C: Environmental Impact Assessment and Life Cycle Analyses

CE(OE)601 (Open Elective-I)

- A: Soft Skills and Interpersonal Communication
B: Introduction to Philosophical Thoughts

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Semester VII (Fourth year)

Sl. No.	Category	Code	Course Title	Hours per week			Credits
				L	T	P	
Theory							
1	Professional Core courses	CE(PC)701	Hydrology & Water Resources Engineering	2	1	0	3
2	Professional Core courses	CE(PC)702	Disaster Preparedness & Planning	1	1	0	2
3	Professional Elective courses	CE(PE)701	Elective V	2	1	0	3
4	Professional Elective courses	CE(PE)702	Elective-VI	2	1	0	3
5	Open Elective courses	CE(OE)701	Open Elective-II (Metro Systems & Engineering) See Annexure-I	3	0	0	3
Theory credits							14
Practical/ Sessional							
1	Project	CE(PROJ)791	Project-1 (Project work, seminar and internship in industry or at appropriate work place)	0	0	12	6
Practical credits							6
Total credits							20

CE(PE)701 (Elective-V)	CE(PE)702 (Elective-VI)
701A: Airport Planning and Design	702A : Intelligent Transportation Systems
701B: Design of Steel Structures	702B : Water and Air Quality Modelling
701C: Groundwater Engineering	702C : Earthquake Engineering
701D: Ground Improvement Techniques	702D: Prestressed Concrete
701E: Ecological Engineering	

CE(OE)701 (Open Elective-II)
A: Metro Systems & Engineering
B: ICT for Development

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Semester VIII (Fourth year)

Sl. No.	Category	Code	Course Title	Hours per week			Credits
				L	T	P	
Theory							
1	Humanities and Social Sciences including Management courses	CE(HS)801	Professional Practice, Law & Ethics	2	0	0	2
2	Professional Elective Courses	CE(PE)801	Elective VII	2	1	0	3
3	Professional Elective	CE(PE)802	Elective VIII	2	0	0	2
4	Open Elective courses	CE(OE)801	Open Elective-III	3	0	0	3
5	Open Elective courses	CE(OE)802	Open Elective-IV	2	0	0	2
Theory credits							12
Practical/ Sessional							
1	Project	CE(PROJ)891	Project-2 (Project work, seminar and internship in industry or at appropriate work place)	0	0	12	6
Practical credits							6
Total credits							18

CE(PE)801 (Elective-VII)	CE(PE)802 (Elective-VIII)
801A : Structural Dynamics 801B: Contracts Management 801C: Traffic Engineering and Management 801D: Rock Mechanics 801E: Physico-Chemical Processes for water and wastewater treatment.	802A : Reliability Analysis of Structures 802B: Railway Engineering. 802C: Environmental Laws and Policy 802D: Environmental Geotechnology

CE(OE)801 (Open Elective-III)	CE(OE)802 (Open Elective-IV)
A: Human Resource Development and Organizational Behavior B: History of Science & Engineering	A: Economic Policies in India B: Cyber Law and Ethics

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TOTAL CREDITS – [38 +(22+21)+(22+19)+(20+18)]=160

SEMESTER –III (2ND YR)

CE(BS)301	Biology (Biology for Engineers)	2L + 1T =	3 Credits
Module 1	<p>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.</p> <p>Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry</p>		2L
Module 2	<p>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, uricotelic, ureotelic (e) Habitatacquatic 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</p> <p>Purpose: To convey that classification <i>per se</i> is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted.</p>		3L
Module 3	<p>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.</p> <p>Purpose: To convey that "Genetics is to biology what Newton's laws are to Physical Sciences"</p>		4L
Module 4	<p>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.</p> <p>Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine</p>		4L
Module 5	<p>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.</p> <p>Purpose: To convey that without catalysis life would not have existed on earth</p>		4L
Module 6	<p>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.\</p> <p>Purpose: The molecular basis of coding and decoding genetic information is universal</p>		4L
Module 7	<p>Macromolecular analysis Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.</p> <p>Purpose: How to analyses biological processes at the reductionistic level</p>		5L
Module 8	<p>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</p> <p>Purpose: The fundamental principles of energy transactions are the same in physical and biological world.</p>		4L
Module 9	<p>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</p>		3L

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	compositions. Growth kinetics.	
Reference	<p>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</p> <p>2) Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons</p> <p>3) Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company</p> <p>4) Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher</p> <p>5) Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers</p>	

CE(ES)301	Engineering Mechanics	3L + 1T =	4 Credits
Module 1	Introduction to Engineering Mechanics Force Systems Basic concepts, Particle equilibrium 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 of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy		6L
Module 2	Friction Types of friction, Limiting friction, Laws of Friction, Static and Dynamic 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; Zero force 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 circular plate, Cylinder, Cone, Sphere, Hook.		5L
Module 5	Virtual Work and Energy Method- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.		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 2 nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique).		4L
Module 7	Introduction to Kinetics of Rigid Bodies Basic terms, general principles in dynamics; 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 energy principle 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 free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, 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 plane; Free body diagrams various systems including block-pulley; To verify the principle of moment in the disc apparatus; Helical block; To draw a load efficiency curve for a screw jack		6L
Reference	<p>1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall</p> <p>2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, -Dynamics, 9th Ed, Tata McGraw Hill</p> <p>3. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.</p> <p>4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press</p> <p>5. Shames and Rao (2006), Engineering Mechanics, Pearson Education,</p> <p>6. Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education</p> <p>7. Reddy Vijaykumar K. and K. Suresh Kumar (2010), Singer's Engineering Mechanics</p> <p>8. Bansal R.K. (2010), A Text Book of Engineering Mechanics, Laxmi Publications</p> <p>9. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.</p> <p>10. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications</p>		

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CE(ES)302	Energy Science & Engineering	1L + 1T =	2 Credits
Module 1	<p>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.</p> <p>Tutorials: Compile a World map showing Energy Reserves by source, Total Energy consumption, Per capita energy consumption and Carbon Footprint</p>		3L
Module 2	<p>Energy Sources Overview of energy systems, sources, transformations, efficiency, and storage. 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 energy storages, high efficiency batteries)</p> <p>Tutorials: Compile a Word Map showing Alternative Energy source usage; Compile a Process diagram for a Pumped Storage project; Collect details of a typical North Sea oil platform. Compile a map of India showing existing potential and utilized potential for hydro power. List the pros and cons for Thermal, hydro, nuclear and solar power projects.</p>		4L
Module 3	<p>Energy & Environment Energy efficiency and conservation; introduction to clean energy technologies and its importance in sustainable development; Carbon footprint, energy consumption and sustainability; introduction to the economics of energy; How the economic system determines production and consumption; linkages between economic and environmental outcomes; How future energy use can be influenced by economic, environmental, trade, and research policy</p> <p>Tutorials: Study the functioning of an Electro Static Precipitator in a thermal power plant; study the uses of coarse and fine Fly Ash from thermal power plants. Compile the safety provisions in design and construction of a reactor containment building</p>		5L
Module 4	<p>Civil Engineering Projects connected with the Energy Sources Coal mining technologies, Oil exploration offshore platforms, Underground and under-sea oil pipelines, solar chimney 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 constraints and testing procedures for reactor containment buildings; Spent Nuclear fuel storage and disposal systems</p> <p>Tutorials: Compile a process diagram for a typical underground hydropower project; Collect details of a model solar chimney project; collect details of a wave energy project at Vizhinjam; Collect details of the Kalpasar (Tidal energy) project</p>		10L
Module 5	<p>Engineering for Energy conservation Concept of Green Building and Green Architecture; Green building concepts (Green building encompasses everything from the choice of building 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 prioritizing these as candidates; Embodied energy analysis and use as a tool for measuring sustainability. Energy Audit of Facilities and optimization of energy consumption.</p> <p>Tutorials: Draw a typical geometrical orientation of a house in your area to avoid sun's radiation in the bed room in the evening; Identify typical examples of Indian buildings having various LEED ratings; List various building materials with their embodied energy content. Do an Energy Audit of your Departmental Building in the college</p>		8L
Reference	<ol style="list-style-type: none"> Boyle, Godfrey (2004), Renewable Energy (2nd edition). Oxford University Press Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004), Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press Schaeffer, John (2007), Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living, Gaia Jean-Philippe; Zaccour, Georges (Eds.), (2005), Energy and Environment Set: Mathematics of Decision Making, Loulou, Richard; Waaub, XVIII, Ristinen, Robert A. Kraushaar, Jack J. A Kraushaar, Jack P. Ristinen, Robert A. (2006) Energy and the Environment, 2nd Edition, John Wiley UNDP (2000), Energy and the Challenge of Sustainability, World Energy assessment E H Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addison-Wesley Publishing Company Related papers published in international journals 		

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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, Chebyshev Polynomials; Trigonometric Polynomials; Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals 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 their applications.		6 L
Module 3	Sets, relations and functions Basic operations on sets, Cartesian products, disjoint union (sum), and power sets. Different types of relations, their compositions and inverses. Different types of functions, their compositions and inverses.		4 L
Module 4	Propositional Logic Syntax and semantics, proof systems, satisfiability, validity, soundness, completeness, deduction theorem, etc. Decision problems of propositional logic. Introduction to first order logic and first order 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’s theorem, normal subgroup, homomorphic subgroup. Congruence relation and quotient structures. Error correcting code. Algebraic structures with two binary operations- ring, integral domain, and field. 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. Veerarajan T., Engineering Mathematics, Tata McGraw-Hill, New Delhi, 2008.		

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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 and document 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 and language. Basics of grammar, study of advanced grammar, editing strategies to achieve appropriate technical style. Introduction to advanced technical communication, Usability, Human factors, Managing technical communication projects, time estimation, Single sourcing, Localization.		8L
Module 3	Self Development and Assessment- Self assessment, Awareness, Perception and Attitudes, 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. Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, 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, Work culture 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. Shiv Khera, You Can Win, Macmillan Books, New York, 2003. 4. Raman Sharma, Technical Communications, Oxford Publication, London, 2004. 5. Dale Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004. (ISBN: 07828357-4) 6. Sharma, R. and Mohan, K. Business Correspondence and Report Writing, TMH New Delhi 2002. 7. Xebec, Presentation Book, TMH New Delhi, 2000. (ISBN 0402213)		

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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 possible roles 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; Position of construction industry vis-à-vis other industries, five year plan outlays for construction; current budgets for infrastructure works Tutorials Develop a Strategic Plan for Civil Engineering works for next ten years based on past investments and identify one typical on-going mega project in each area		1 L
Module 4	Fundamentals of Architecture & Town Planning: Aesthetics in Civil Engineering, Examples of great architecture, fundamentals of architectural design & town planning; Building Systems (HVAC, Acoustics, Lighting, etc.); LEED ratings; Development of Smart cities Tutorials Identify ten best civil engineering projects with high aesthetic appeal with one possible factor for each; List down the possible systems required for a typical Smart City		1 L
Module 5	Fundamentals of Building Materials: Stones, bricks, mortars, Plain, Reinforced & Prestressed Concrete, 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 in construction; 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 their advantages/ 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 built environment, water treatment systems, and good practices of wastewater management. examples of Solid and hazardous waste management, Air pollution and control		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 of any one Metro Rail (underground) project; Visit a construction site and make a site visit report		2 L
Module 9	Hydraulics, Hydrology & Water Resources Engineering: Fundamentals of fluid flow, basics of water supply systems; Underground Structures; Underground Structures Multi-purpose reservoir projects Tutorials Identify three river interlinking projects and their features; 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 structures available in them; Visit a related/similar		1 L

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	facility, if possible in nearby place and make a report	
Module 11	Power Plant Structures: Chimneys, Natural & Induced Draught Colling towers, coal handling 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 the structures and systems falling in them.	1 L
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; Visit Structures 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 Total Station and LIDAR and compare; Study typical Google street map and Google Earth Map and study how each can facilitate the other	1 L
Module 14	Traffic & Transportation Engineering: Investments in transport infrastructure development in India 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 under heterogeneous traffic; Sustainable and resilient pavement materials, design, construction and management; Case studies and examples. Tutorials Investments in transport infrastructure; Developments and challenges; Intelligent Transport Systems; Smart Cities, Urban Transport; Road Safety; Sustainable and resilient highway design principles; Plan a sustainable transport system for a city; Identify key features/components in the planning and design of a green 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-Destructive testing systems; Use of carbon fibre wrapping and carbon composites in repairs. Tutorials Collect the history of a major rehabilitation project and list 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 ten interesting software systems used in Civil Engg and their 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 list preventive measures; Identify 5 interesting projects and their positive features; Write 400 word reports on one ancient monument and a modern marvel of civil engineering	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.	

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	<p>11. Wadhwa (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</p>	
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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 Rectifier, 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 Oxide Semiconductor (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 and Printed 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 Sinusoidal Signals 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 Output Characteristics of BJT in Common Emitter (CE) Configuration, Drain and Transfer Characteristics of JFET in Common Source (CS) Configuration;		

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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 Monostable Multivibrators;	
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 D Flip-Flop ICs; Serial-In-Serial-Out and Serial-In-Parallel-Out Shift operations using 4-bit/8-bit Shift Register 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. Santiram Kal (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 typical drawings, Planning drawings to show information concisely and comprehensively; optimal layout of drawings and Scales; Introduction to computer aided drawing, co-ordinate systems, reference planes. Commands: Initial settings, Drawing aids, Drawing basic entities, Modify commands, Layers, Text and Dimensioning, Blocks. Drawing presentation norms and standards.		2 L
Module 2	SYMBOLS AND SIGN CONVENTIONS Materials, Architectural, Structural, Electrical and Plumbing symbols. Rebar drawings and structural steel fabrication and connections drawings symbols, 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 of making line drawing and detailed drawing. Site plan, floor plan, elevation and section drawing of small residential buildings. Foundation plan. Roof drainage plans. Depicting joinery, standard fittings & fixtures, finishes. Use of Notes to improve clarity		5 L
Module 5	PICTORIAL VIEW Principles of isometrics and perspective drawing. Perspective view of 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 the Facility 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. Ajeet Singh (2002), “Working with AUTOCAD 2000 with updates on AUTOCAD 2001”, Tata- Mc Graw-Hill Company Limited, New Delhi 3. Sham Tickoo Swapna D (2009), “AUTOCAD for Engineers and Designers”, Pearson Education, 4. Venugopal (2007), “Engineering Drawing and Graphics + AUTOCAD”, New Age International Pvt. Ltd., 5. Balagopal and Prabhu (1987), “Building Drawing and Detailing”, Spades publishing KDR building, Calicut, 6. (Corresponding set of) CAD Software Theory and User Manuals. 7. Malik R.S., Meo, G.S. (2009) Civil Engineering Drawing, Computech Publication Ltd New Asian.		

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	8. Sikka, V.B. (2013), A Course in Civil Engineering Drawing, S.K.Kataria& Sons,
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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		

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Semester IV [Second year]

CE(ES)401	Mechanical Engineering	2L + 1T	3 Credits
Module 1	Basic Concepts- Basic concepts - concept of continuum, macroscopic approach, Thermodynamic systems - closed, open and isolated. Property, state, path and process, quasistatic process, work, modes of work. Zeroth law of thermodynamics, concept of temperature and heat. Concept of ideal and real gases.		4L
Module 2	First Law of Thermodynamics- Concepts of Internal Energy, Specific Heat Capacities, Enthalpy. Energy Balance for Closed and Open Systems, Energy Balance for Steady-Flow Systems. Steady-Flow Engineering Devices. Energy Balance for Unsteady-Flow		4L
Module 3	Second Law of Thermodynamics- Thermal energy reservoirs, heat engines energy conversion, Kelvin's and Clausius statements of second law, the Carnot cycle, the Carnot Theorem, the thermodynamic temperature scale, the Carnot heat engine, efficiency, the Carnot refrigerator and heat pump, COP. Clausius inequality, concept of entropy, principle of increase of entropy – availability, the increase of entropy principle, perpetual-motion machines, reversible and irreversible processes, Entropy change of pure substances, isentropic processes, property diagrams involving entropy, entropy change of liquids and solids, the entropy change of ideal gases, reversible steady flow work, minimizing the compressor work, isentropic efficiencies of steady-flow devices, and entropy balance. Energy - a measure of work potential, including work potential of energy, reversible work and irreversibility, second-law efficiency, exergy change of a system, energy transfer by heat, work, and mass, the decrease of exergy principle and exergy destruction, energy balance: closed systems and control volumes energy balance.		10L
Module 4	Properties Of Pure Substance- Properties of pure substances. Thermodynamic properties of pure substances in solid, liquid and vapour phases. Phase rule, P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces. Thermodynamic properties of steam. Calculations of work done and heat transfer in non-flow and flow processes.		6L
Module 5	Power Cycles- Vapour and combined power cycles, including the Carnot vapor cycle, Rankine cycle: the ideal cycle for vapor power, the ideal reheat and regenerative and the second-law analysis of vapour power cycles. Gas power cycles, including basic considerations in the analysis of power cycles, the Carnot cycle and its value in engineering, an overview of reciprocating engines, air standard assumptions, gasoline engine Otto cycle, diesel engine cycle, gas-turbine Brayton cycle, and the second-law analysis of gas power cycles.		6L
Module 6	Ideal and Real Gases and Thermodynamic Relations- Gas mixtures – properties ideal and real gases. Equation of state, Avogadro's Law, Vander Waal's equation of state, Compressibility factor, compressibility chart. Dalton's law of partial pressure. Exact differentials, T-D relations, Maxwell's relations. Clausius Clapeyron equations, Joule – Thomson coefficient.		6L
Module 7	Psychrometry and psychrometric charts, property calculations of air vapour mixtures. Psychrometric process – Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, evaporative cooling. Use of standard thermodynamic tables, Mollier diagram, Psychrometric chart and Refrigerant property tables. Refrigeration cycles, including refrigerators and heat pumps, the ideal reversed Carnot vapour-compression refrigeration cycle, actual vapor compression refrigeration cycles, heat pump systems, gas refrigeration cycles, and absorption refrigeration systems.		6L
Reference	1. Nag. P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi. 2. Cengel, Thermodynamics – An Engineering Approach, Tata McGraw Hill, New Delhi. 3. Sonntag, R. E., Borgnakke, C., & Wylen, G. J. V. Fundamentals of thermodynamics: Wiley. 4. Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. Fundamentals of Engineering Thermodynamics: John Wiley & Sons. 5. Jones, J. B., & Dugan, R. E. Engineering thermodynamics: Prentice Hall. 6. Potter, M. C., & Somerton, C. W. Schaum's Outline of Thermodynamics for Engineers, McGraw-Hill.		

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CE(PC)401	Instrumentation & Sensor Technologies for Civil Engineering Applications	1L + 1T	2 Credits
Module 1:	Fundamentals of Measurement, Sensing and Instrumentation definition of measurement and instrumentation, physical variables, common types of sensors; Describe the function of these sensors; Use appropriate terminology to discuss sensor applications; and qualitatively interpret signals from a known sensor type, types of instrumentation, Sensor Specifics, Permanent installations, Temporary installations;		4L
Module 2	Sensor Installation and Operation i) Predict the response of sensors to various inputs; ii) Construct a conceptual instrumentation and monitoring program; iii) Describe the order and methodology for sensor installation; and iv) Differentiate between types of sensors and their modes of operation and measurement and v) Approach to Planning Monitoring Programs, Define target, Sensor selection, Sensor siting, Sensor Installation & Configuration, Advanced topic, Sensor design, Measurement uncertainty		6L
Module 3	Data Analysis and Interpretation a) Fundamental statistical concepts, b) Data reduction and interpretation, c) Piezometer, Inclinator, Strain gauge, etc. d) Time domain signal processing, e) Discrete signals, Signals and noise and f) a few examples of statistical information to calculate are: Average value (mean), On average, how much each measurement deviates from the mean (standard deviation), Midpoint between the lowest and highest value of the set (median), Most frequently occurring value (mode), Span of values over which your data set occurs (range)		6L
Module 4:	Frequency Domain Signal Processing and Analysis covering Explain the need for frequency domain analysis and its principles; Draw conclusions about physical processes based on analysis of sensor data; Combine signals in a meaningful way to gain deeper insight into physical phenomena, Basic concepts in frequency domain signal processing and analysis, Fourier Transform, FFT (Fast Fourier Transform), Example problems: Noise reduction with filters, Leakage, Frequency resolution		6L
Tutorials	Tutorials from the above modules demonstrating clearly the understanding and use for the sensors and instruments used for the problems posed and inferences drawn from the measurement and observations made along with evaluation report		6L
Reference	1. Alan S Morris (2001), Measurement and Instrumentation Principles, 3rd/e, Butterworth Hienemann 2. David A. Bell (2007), Electronic Instrumentation and Measurements 2nd/e, Oxford Press 3. S. Tumanski (2006), Principle of Electrical Measurement, Taylor & Francis 4. Ilya Gertsbakh (2010), Measurement Theory for Engineers, Springer		

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CE(PC)403	Introduction to Fluid Mechanics	2L + 0T	2 Credits
Module 1	Basic Concepts and Definitions – Distinction between a fluid and a solid; Density, Specific weight, Specific gravity, Kinematic and dynamic viscosity; variation of viscosity with temperature, Newton law of viscosity; vapour pressure, boiling point, cavitation; surface tension, capillarity, Bulk modulus of elasticity, compressibility.		4L
Module 2	Fluid Statics - Fluid Pressure: Pressure at a point, Pascals law, pressure variation with temperature, density and altitude. Piezometer, U-Tube Manometer, Single Column Manometer, U Tube Differential Manometer, Micromanometers. pressure gauges, Hydrostatic pressure and force: horizontal, vertical and inclined surfaces. Buoyancy and stability of floating bodies.		6L
Module 3	Fluid Kinematics-Classification of fluid flow : steady and unsteady flow; uniform and non-uniform flow; laminar and turbulent flow; rotational and irrotational flow; compressible and incompressible flow; ideal and real fluid flow; one, two and three dimensional flows; Stream line, path line, streak line and stream tube; stream function, velocity potential function. One-, two- and three-dimensional continuity equations in Cartesian coordinates		9L
Module 4	Fluid Dynamics- Surface and body forces; Equations of motion - Euler's equation; Bernoulli's equation – derivation; Energy Principle; Practical applications of Bernoulli's equation : venturimeter, orifice meter and pitot tube; Momentum principle; Forces exerted by fluid flow on pipe bend; Vortex Flow – Free and Forced; Dimensional Analysis and Dynamic Similitude – Definitions of Reynolds Number, Froude Number, Mach Number, Weber Number and Euler Number; Buckingham's π -Theorem.		9L
Reference	1. Fluid Mechanics and Machinery, C.S.P. Ojha, R. Berndtsson and P. N. Chadramouli, Oxford University Press, 2010 2. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House 3. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill 4. Fluid Mechanics with Engineering Applications, R.L. Daugherty, J.B. Franzini and E.J. Finnemore, International Student Edition, Mc Graw Hill.		

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CE(PC)404	Introduction to Solid Mechanics	2L + 0T	2 Credits
Module 1	Simple Stresses and Strains- Concept of stress and strain, St. Venant's principle, stress and strain diagram, Elasticity and plasticity – Types of stresses and strains, Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio and volumetric strain – Elastic moduli and the relationship between them – Bars of varying section – composite bars – Temperature stresses. Strain Energy – Resilience – Gradual, sudden, impact and shock loadings – simple applications.		4L
Module 2	Compound Stresses and Strains- Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr circle of stress, ellipse of stress and their applications. Two dimensional stress-strain system, principal strains and principal axis of strain, circle of strain and ellipse of strain. Relationship between elastic constants.		4L
Module 3:	Bending moment and Shear Force Diagrams- Bending moment (BM) and shear force (SF) diagrams. BM and SF diagrams for cantilevers simply supported and fixed beams with or without overhangs. Calculation of maximum BM and SF and the point of contra flexure under concentrated loads, uniformly distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments.		6L
Module 4:	Flexural Stresses-Theory of simple bending – Assumptions – Derivation of bending equation: $M/I = f/y = E/R$ - Neutral axis – Determination of bending stresses – Section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections – Design of simple beam sections.		4L
Module 5:	Shear Stresses- Derivation of formula – Shear stress distribution across various beam sections like rectangular, circular, triangular, I, T angle sections.		4L
Module 6	Slope and deflection- Relationship between moment, slope and deflection, Moment area method, Macaulay's method. Use of these methods to calculate slope and deflection for determinant beams.		4L
Module 7	Torsion- Derivation of torsion equation and its assumptions. Applications of the equation of the hollow and solid circular shafts, torsional rigidity, Combined torsion and bending of circular shafts, principal stress and maximum shear stresses under combined loading of bending and torsion. Analysis of close-coiled-helical springs.		4L
Module 8	Thin Cylinders and Spheres- Derivation of formulae and calculations of hoop stress, longitudinal stress in a cylinder, and sphere subjected to internal pressures.		4L
Reference	1 Elements of Strength of Material S. P. Timoshenko & D. H. Young EWP Pvt. Ltd 2 Engineering Mechanics of Solids E. P. Popov Pearson Education 3 Strength of Materials R. Subramanian OXFORD University Press 4 Strength of Material Bansal 5 Strength of Materials S S Bhavikatti Vikas Publishing House Pvt. Ltd 6 Strength of Material A. Pytel & F. L. Singer AWL Inc 7 Strength of Material Ramamrutham 8 Engineering Mechanics I by J. L. Mariam John Willey 9 Engineering Mechanics I. H. Shames PHI 10 Fundamentals of Strength of Material Nag & Chandra WIE		

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CE(PC)405	Surveying & Geomatics	1L + 1T	2 Credits
Module 1	<p>Introduction to Surveying Principles, Linear, angular and graphical methods, Survey stations, Survey lines- ranging, Bearing of survey lines, Levelling: Plane table surveying, Principles of levelling- booking and reducing levels; differential, reciprocal leveling, profile levelling and cross sectioning. Digital and Auto Level, Errors in levelling; contouring: Characteristics, methods, uses; areas and volumes.</p> <p>Triangulation and Trilateration Theodolite survey: Instruments, Measurement of horizontal and vertical angle; Horizontal and vertical control - methods - triangulation - network - Signals. Baseline - choices - instruments and accessories - extension of base lines - corrections - Satellite station - reduction to centre - Intervisibility of height and distances - Trigonometric levelling - Axis single corrections.</p>		10 L
Module 2:	<p>Curves Elements of simple and compound curves – Method of setting out – Elements of Reverse curve - Transition curve – length of curve – Elements of transition curve - Vertical curves</p>		5L
Module 3	<p>Modern Field Survey Systems Principle of Electronic Distance Measurement, Modulation, Types of EDM instruments, Distomat, Total Station – Parts of a Total Station – Accessories – Advantages and Applications, Field Procedure for total station survey, Errors in Total Station Survey; Global Positioning Systems - Segments, GPS measurements, errors and biases, Surveying with GPS, Co-ordinate transformation, accuracy considerations.</p>		8L
Module 4	<p>Photogrammetry Surveying Introduction, Basic concepts, perspective geometry of aerial photograph, relief and tilt displacements, terrestrial photogrammetry, flight planning; Stereoscopy, ground control extension for photographic mapping- aerial triangulation, radial triangulation, methods; photographic mapping- mapping using paper prints, mapping using stereo plotting instruments, mosaics, map substitutes.</p>		6L
Module 5	<p>Remote Sensing Introduction – Electromagnetic Spectrum, interaction of electromagnetic radiation with the atmosphere and earth surface, remote sensing data acquisition: platforms and sensors; visual image interpretation; digital image processing.</p>		4 L
Reference	<ol style="list-style-type: none"> 1. Madhu, N, Sathikumar, R and Satheesh Gobi, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson India, 2006. 2. Manoj, K. Arora and Badjatia, Geomatics Engineering, Nem Chand & Bros, 2011 3. Bhavikatti, S.S., Surveying and Levelling, Vol. I and II, I.K. International, 2010 4. Chandra, A.M., Higher Surveying, Third Edition, New Age International (P) Limited, 2002. 5. Anji Reddy, M., Remote sensing and Geographical information system, B.S. Publications, 2001. 6. Arora, K.R., Surveying, Vol-I, II and III, Standard Book House, 2015. 		

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CE(PC)406	Materials, Testing & Evaluation	1L + 1T	2 Credits
Module 1	Introduction to Engineering Materials Cements, M-Sand, Concrete (plain, reinforced and steel fibre/ glass fibre-reinforced, light-weight concrete, High Performance Concrete, Polymer Concrete) Ceramics, and Refractories, Bitumen and asphaltic materials, Timbers, Glass and Plastics, Structural Steel and other Metals, Paints and Varnishes, Acoustical material and geotextiles, rubber and asbestos, laminates and adhesives, Graphene, Carbon composites and other engineering materials including properties and uses of these		5L
Module 2	Introduction to Material Testing What is the “Material Engineering”?; Mechanical behavior and mechanical characteristics; Elasticity – principle and characteristics; Plastic deformation of metals; Tensile test – standards for different material (brittle, quasi-brittle, elastic and so on) True stress – strain interpretation of tensile test; hardness tests; Bending and torsion test; strength of ceramic; Internal friction, creep – fundamentals and characteristics; Brittle fracture of steel – temperature transition approach; Background of fracture mechanics; Discussion of fracture toughness testing – different materials; concept of fatigue of materials; Structural integrity assessment procedure and fracture mechanics		8L
Module 3	Standard Testing & Evaluation Procedures covering, Laboratory for mechanical testing; Discussion about mechanical testing; Naming systems for various irons, steels and nonferrous metals; Discussion about elastic deformation; Plastic deformation; Impact test and transition temperatures; Fracture mechanics – background; Fracture toughness – different materials; Fatigue of material; Creep.		8L
Tutorials	Tutorials from the above modules covering, understanding i) Tests & testing of bricks, ii) Tests & testing of sand, iii) Tests & testing of concrete, iv) Tests & testing of soils, v) Tests & testing of bitumen & bituminous mixes, vi) Tests & testing of polymers and polymer based materials, vii) Tests & testing of metals & viii) Tests & testing of other special materials, composites and cementitious materials. Explanation of mechanical behavior of these materials.		7L
Reference	1. Chudley, R., Greeno (2006), 'Building Construction Handbook' (6th ed.), R. Butterworth-Heinemann 2. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, ' Highway Materials and Pavement Testing', Nem Chand & Bros, Fifth Edition 3. Various related updated & recent standards of BIS, IRC, ASTM, RILEM, AASHTO, etc. corresponding to materials used for Civil Engineering applications 4. Kyriakos Komvopoulos (2011), Mechanical Testing of Engineering Materials, Cognella 5. E.N. Dowling (1993), Mechanical Behaviour of Materials, Prentice Hall International Edition 6. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards (post 2000) 7. Related papers published in international journals		

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CE(HS)401	Civil Engineering - Societal & Global Impact	2L + 0T	2 Credits
Module 1	Introduction to Course and Overview; Understanding the past to look into the future: Preindustrialrevolution days, Agricultural revolution, first and second industrial revolutions, ITrevolution; Recent major Civil Engineering breakthroughs and innovations; Present day world andfuture projections, Ecosystems in Society and in Nature; the steady erosion in Sustainability; Globalwarming, its impact and possible causes; Evaluating future requirements for various resources; GISand applications for monitoring systems; Human Development Index and Ecological Footprint ofIndia Vs other countries and analysis;		5L
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 forCivil Engineering		4L
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 variousCodes & Standards governing Infrastructure development; Innovations and methodologies forensuring Sustainability;		8L
Module 4	Environment-Traditional & futuristic methods; Solid waste management, Waterpurification, Wastewater treatment & Recycling, Hazardous waste treatment; Flood control (Dams,Canals, River interlinking), Multi-purpose water projects, Atmospheric pollution; Global warmingphenomena and Pollution Mitigation measures, Stationarity and non-stationarity; EnvironmentalMetrics & Monitoring; Other Sustainability measures; Innovations and methodologies for ensuringSustainability.		8L
Module 5	Built environment-Facilities management, Climate control; Energy efficient builtenvironments and LEED ratings, Recycling, Temperature/ Sound control in built environment, Security systems; Intelligent/ Smart Buildings; Aesthetics of built environment, Role of Urban ArtsCommissions; Conservation, Repairs & Rehabilitation of Structures & Heritage structures; Innovations and methodologies for ensuring Sustainability		7L
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 aspectsof Civil Engineering Projects; New Project Management paradigms & Systems (Ex. LeanConstruction), contribution of Civil Engineering to GDP, Contribution to employment(projects,facilities management), Quality of products, Health & Safety aspects for stakeholders; Innovationsand methodologies for ensuring Sustainability during Project development;		8L
Reference	<ol style="list-style-type: none"> 1. Ziga Turk (2014), 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. Springer, Dordrecht 2. NAE Grand Challenges for Engineering (2006), Engineering for the Developing World, The Bridge, Vol 34, No.2, Summer 2004. 3. Barry M. (2003) Corporate social responsibility – unworkable paradox or sustainable paradigm? Proc ICE Engineering Sustainability 156. Sept Issue ES3 paper 13550. p 129-130 4. Cavill S., Sohail M. (2003) Accountability in the provision of urban services. Proc. ICE. Municipal Engineer 156. Issue ME4 paper 13445, p235-244. 5. Brugnach M., Dewulf A., Pahl-Wostl C., Tailieu T. (2008) Toward a relational concept of uncertainty: about knowing too little, knowing too differently and accepting not to know. Ecology and Society 13 (2): 30 		

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CE(MC)401	Management I (Organizational Behaviour)	3L + 0T	0 Credits
Module 1	Introduction, Foundations of individual behaviour-Ability, Attitudes , Job Satisfaction, Personality, Values , Perception		4L
Module 2	Motivation–Theories, leadership, Foundations of Group behaviour -Group development; Group properties: Roles, norms, status, size and cohesiveness, Group decision making, Techniques, Work teams		10L
Module 3	Organisation Design: Understanding organizations-Basics of an organizational design-Organization and stakeholders-Organizations and environmental influences-Organizational strategy-Organizational design -Alternative structures-Management process - Authority and organizational control mechanisms-Managing organizational culture Technology and organizational design- Organizational decision making and organizational learning & knowledge management-Organizational life cycle and change management- Managing organizational conflict, power and politics		14L
Module 4	Organizational Change and Development: Dynamics of planned change, models and theories of planned change, triggers for change, strategies for implementing organizational change, Conceptual Framework of OD, OCTAPACE model of climate survey. Managing OD Process, Classification of OD interventions, team building Interventions, structural interventions, comprehensive OD interventions, Power and Politics in OD, Issues in Client Consultant Relationship, Interdisciplinary nature of OD		6L
Module 5	Leadership: Roles of a leader, Leadership theory paradigms, analysis of leadership theory; Leadership traits and ethics: Personality traits and leadership, Leadership attitudes, ethical leadership, Leadership behavior and motivation, contingency leadership, Team Leadership, Organizational Leadership, Strategic leadership, Leadership for Creating high performance culture, Leadership development through self-awareness and self-discipline, Development through education, experience and mentoring, Succession, Evaluation of leadership development efforts, Indian cases on leadership		8L
Reference	1. Organisational Behaviour by Inder Jeet Suman Solanki, Edition : 2017 Edition ,ISBN No.:9789386635549, TAXMANN'S 2. Organizational Behavior, , by Stephen P. Robbins, Timothy A Judge, Neharika Vohra, 16/e Sixteenth Edition ,Pearson Publishers 3. Organisational Behaviour (Text and Cases) by Dr. S.S. Khanka, S. Chand. & Company Pvt. Ltd.		

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CE(PC)491	Instrumentation & Sensor Technologies for Civil Engineering Applications	0L + 2P	1 Credits
1	Instrumentation of typical civil engineering members/structures/structural elements		
2	Use of different sensors, strain gauges, inclinometers,		
3	Performance characteristics		
4	Errors during the measurement process		
5	Calibration of measuring sensors and instruments		
6	Measurement, noise and signal processing		
7	Analog Signal processing		
8	Digital Signal Processing		
9	Demonstration & use of sensor technologies		

CE(PC)492	Engineering Geology	1L + 2P	2 Credits
Theory			
Module 1	Introduction-Branches of geology useful to civil engineering, scope of geological studies in various civil engineering projects. Department dealing with this subject in India and their scope of work- GSI, Granite Dimension Stone Cell, NIRM. Mineralogy-Mineral, Origin and composition. Physical properties of minerals, susceptibility of minerals to alteration, basic of optical mineralogy, SEM, XRD., Rock forming minerals, megascopic identification of common primary & secondary minerals.		4L
Module 2	Petrology-Rock forming processes. Specific gravity of rocks. Ternary diagram. Igneous petrology- Volcanic Phenomenon and different materials ejected by volcanoes. Types of volcanic eruption. Concept of Hot spring and Geysers. Characteristics of different types of magma. Division of rock on the basis of depth of formation, and their characteristics. Chemical and Mineralogical Composition. Texture and its types. Various forms of rocks. IUGS Classification of phaneritic and volcanic rock.. Field Classification chart. Structures. Classification of Igneous rocks on the basis of Chemical composition. Detailed study of Acidic Igneous rocks like Granite, Rhyolite or Tuff, Felsite, Pegmatite, Hornfels. Metamorphic Aureole, Kaolinization. Landform as Tors. Engineering aspect to granite. Basic Igneous rocks Like Gabbro, Dolerite, Basalt. Engineering aspect to Basalt. Sedimentary petrology- mode of formation, Mineralogical Composition. Texture and its types, Structures, Gradation of Clastic rocks. Classification of sedimentary rocks and their characteristics. Detailed study of Conglomerate, Breccia, Sandstone, Mudstone and Shale, Limestone Metamorphic petrology- Agents and types of metamorphism, metamorphic grades, Mineralogical composition, structures & textures in metamorphic rocks. Important Distinguishing features of rocks as Rock cleavage, Schistosity, Foliation. Classification. Detailed study of Gneiss, Schist, Slate with engineering consideration.		6L
Module 3	Physical Geology- Weathering. Erosion and Denudation. Factors affecting weathering and product of weathering. Engineering consideration. Superficial deposits and its geotechnical importance: Water fall and Gorges, River meandering, Alluvium, Glacial deposits, Laterite (engineering aspects), Desert Landform, Loess, Residual deposits of Clay with flints, Solifluction deposits, mudflows, Coastal deposits.		3L
Module 4	Strength Behavior of Rocks- Stress and Strain in rocks. Concept of Rock Deformation & Tectonics. Dip and Strike. Outcrop and width of outcrop. Inliers and Outliers. Main types of discontinuities according to size. Fold- Types and nomenclature, Criteria for their recognition in field. Faults: Classification, recognition in field, effects on outcrops. Joints & Unconformity; Types, Stresses responsible, geotechnical importance. Importance of structural elements in engineering operations. Consequences of failure as land sliding, Earthquake and Subsidence. Strength of Igneous rock structures.		3L
Module 5:	Geological Hazards-Rock Instability and Slope movement: Concept of sliding blocks. Different controlling factors. Instability in vertical rock structures and measures to prevent collapse. Types of landslide. Prevention by surface drainage, slope reinforcement by Rock bolting and Rock anchoring, retaining wall, Slope treatment. Case study on black clay. Ground water: Factors controlling water bearing capacity of rock. Pervious & impervious rocks and ground water. Lowering of water table and Subsidence. Earthquake: Magnitude and intensity of earthquake. Seismic sea waves. Revelation from Seismic Records of structure of earth. Case Study on Elevation and Subsidence in Himalayan region in India. Seismic Zone in India.		3L
Module 6	Rock masses as construction material: Definition of Rock masses. Main features constituting rock mass. Main features that affects the quality of rock engineering and design. Basic element and structures of rock those are relevant in civil engineering areas. Main types of works connected to rocks and rock masses. Important variables influencing rock properties and behaviour such as Fresh rock Influence from some minerals. Effect of alteration and weathering. Measurement of velocity of sound in rock. Classification of Rock material strength. Core logging. Rock Quality Designation. Rock mass description.		3L
Module 7	Geology of dam and reservoir site- Required geological consideration for selecting dam and reservoir site. Failure of Reservoir. Favourable & unfavourable conditions in different types of		3L

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	rocks in presence of various structural features, precautions to be taken to counteract unsuitable conditions, significance of discontinuities on the dam site and treatment giving to such structures.	
Module 8	Rock Mechanics- Sub surface investigations in rocks and engineering characteristics of rocks masses; Structural geology of rocks. Classification of rocks, Field & laboratory tests on rocks, Stress deformation of rocks, Failure theories and shear strength of rocks, Bearing capacity of rocks.	3L
Laboratory		
	<ol style="list-style-type: none"> 1. Study of physical properties of minerals. 2. Study of different group of minerals. 3. Study of Crystal and Crystal system. 4. Identification of minerals: Silica group: Quartz, Amethyst, Opal; Feldspar group: Orthoclase, Plagioclase; Cryptocrystalline group: Jasper; Carbonate group: Calcite; Element group: Graphite; Pyroxene group: Talc; Mica group: Muscovite; Amphibole group: Asbestos, Olivine, Hornblende, Magnetite, Hematite, Corundum, Kyanite, Garnet, Galena, Gypsum. 5. Identification of rocks (Igneous Petrology): Acidic Igneous rock: Granite and its varieties, Syenite, Rhyolite, Pumice, Obsidian, Scoria, Pegmatite, Volcanic Tuff. Basic rock: Gabbro, Dolerite, Basalt and its varieties, Trachyte. 6. Identification of rocks (Sedimentary Petrology): Conglomerate, Breccia, Sandstone and its varieties, Laterite, Limestone and its varieties, Shales and its varieties. 7. Identification of rocks (Metamorphic Petrology): Marble, slate, Gneiss and its varieties, Schist and its varieties. Quartzite, Phyllite. 8. Study of topographical features from Geological maps. Identification of symbols in maps. 	
Reference	<ol style="list-style-type: none"> 1. Engineering and General Geology, Parbin Singh, 8th Edition (2010), S K Kataria & Sons. 2. Text Book of Engineering Geology, N. Chenna Kesavulu, 2nd Edition (2009), Macmillan Publishers India. 3. Geology for Geotechnical Engineers, J.C. Harvey, Cambridge University Press (1982). 	

CE(PC)493	Introduction to Fluid Mechanics	0L + 2P	1 Credits
	<ol style="list-style-type: none"> 1. Measurement of viscosity 2. Study of Pressure Measuring Devices 3. Stability of Floating Body 4. Hydrostatics Force on Flat Surfaces/Curved Surfaces 5. Verification of Bernoulli's Theorem 6. Venturimeter 7. Orifice meter 8. Impacts of jets 9. Flow Visualisation -Ideal Flow 10. Length of establishment of flow 11. Velocity distribution in pipes 12. Laminar Flow 		

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CE(PC)494	Surveying & Geomatics	0L + 2P	1 Credits
	<ol style="list-style-type: none">1. Chain surveying: Preparing index plans, Location sketches, Ranging, Preparation of map, Heights of objects using chain and ranging rods, Getting outline of the structures by enclosing them in triangles/quadrilaterals, Distance between inaccessible points, Obstacles in chain survey.2. Compass surveying: Measurement of bearings, Preparation of map, Distance between two inaccessible points by chain and compass, Chain and compass traverse3. Plane Table survey: Temporary adjustments of plane table and Radiation method, Intersection, Traversing and Resection methods of plane tabling, Three-point problem4. Leveling: Temporary adjustment of Dumpy level, Differential leveling, Profile leveling and plotting the profile, Longitudinal and cross sectioning, Gradient of line and setting out grades, Sensitiveness of Bubble tube4. Contouring Direct contouring, Indirect contouring – Block leveling, Indirect contouring – Radial contouring, Demonstration of minor instruments5. Traversing by Using Theodolite: Preparation of Gales Table from field data6. Traversing by using Total Station7. Use of Total Station for leveling and Contouring8. Setting out of Simple Curves9. Interpretation of images using Remote Sensing Softwares		

CE(PC)495	Materials, Testing & Evaluation	0L + 2P	1 Credits
	<ol style="list-style-type: none">1. Gradation of coarse and fine aggregates2. Different corresponding tests and need/application of these tests in design and quality control3. Tensile Strength of materials & concrete composites4. Compressive strength test on aggregates5. Tension I - Elastic Behaviour of metals & materials6. Tension II - Failure of Common Materials7. Direct Shear - Frictional Behaviour8. Concrete I - Early Age Properties9. Concrete II - Compression and Indirect Tension10. Compression – Directionality11. Soil Classification12. Consolidation and Strength Tests13. Tension III - Heat Treatment14. Torsion test15. Hardness tests (Brinell's and Rockwell)16. Tests on closely coiled and open coiled springs17. Theories of Failure and Corroboration with Experiments18. Tests on unmodified bitumen and modified binders with polymers19. Bituminous Mix Design and Tests on bituminous mixes - Marshall method20. Concrete Mix Design as per BIS		

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Semester V [Third year]

CE(PC)501	Mechanics of Materials	3L + 0T	3 Credits
Module 1:	Deformation and Strain covering description of finite deformation, Infinitesimal deformation; Analysis of statically determinate trusses; Stability of dams, retaining walls and chimneys; Stress analysis of thin, thick and compound cylinder;		4L
Module 2:	Generalized state of stress and strain Stress and strain tensor, Yield criteria and theories of failure; Tresca, Von-Mises, Hill criteria, Heigh-Westerguard's stress space.		4L
Module 3:	Momentum Balance and Stresses Forces and Moments Transmitted by Slender Members, Shear Force and Bending Moment Diagrams, Momentum Balance, Stress States / Failure Criterion		5L
Module 4:	Mechanics of Deformable Bodies Force-deformation Relationships and Static Indeterminacy, Uniaxial Loading and Material Properties, Trusses and Their Deformations, Statically Determinate and Indeterminate Trusses,		6L
Module 5:	Force-Stress-Equilibrium Multiaxial Stress and Strain		2L
Module 6:	Displacement – Strain Multiaxial Strain and Multiaxial Stress-strain Relationships		3L
Module 7:	Elasticity and Elasticity Bounds Stress-strain-temperature Relationships and Thin-walled Pressure Vessels, Stress and strain Transformations and Principal Stress, Failure of Materials,		4L
Module 8	Bending; Stress and Strains; Deflections and Torsion Pure Bending, Moment curvature Relationship, Beam Deflection, Symmetry, Superposition, and Statically Indeterminate Beams, Shear and Torsion, Torsion and Twisting, Thermoelasticity, Energy methods, Variational Methods; Strain energy, elastic, complementary and total strain energy, Strain energy of axially loaded bar, Beam in bending, shear and torsion; General energy theorems, Castigliano's theorem, Maxwell's reciprocal theorem; Virtual work and unit load method for deflection, Application to problems of beams and frames.		8L
Module 9	Structural stability; Stability of columns, Euler's formula, end conditions and effective length factor, Columns with eccentric and lateral load; Plasticity and Yield Design covering 1D Plasticity– An Energy Approach, Plasticity Models, Limit Analysis and Yield Design		6L
Reference	1. Norris, C.H. and Wilber, J. B. and Utku, S. "Elementary Structural Analysis" Mc Graw-Hill, Tokyo, Japan 2. Kazmi, S. M. A., 'Solid Mechanics" TMH, Delhi, India 3. Courtney, T. H. Mechanical Behaviour of Materials. McGraw-Hill, 1990 4. Hibbeler, R. C. Mechanics of Materials. 6th ed. East Rutherford, NJ: Pearson Prentice Hall, 2004		

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CE(PC)502	Hydraulic Engineering	2L + 0T	2 Credits
Module 1	Laminar Flow- Laminar flow through: circular pipes, annulus and parallel plates. Stoke's law, Measurement of viscosity.		3L
Module 2	Turbulent Flow- Reynolds experiment, Transition from laminar to turbulent flow. Definition of turbulence, scale and intensity, Causes of turbulence, instability, mechanism of turbulence and effect of turbulent flow in pipes. Reynolds stresses, semi-empirical theories of turbulence, Prandtl's mixing length theory, universal velocity distribution equation. Resistance to flow of fluid in smooth and rough pipes, Moody's diagram.		4L
Module 3	Boundary Layer Analysis-Assumption and concept of boundary layer theory. Boundary layer thickness, displacement, momentum & energy thickness, laminar and Turbulent boundary layers on a flat plate; Laminar sub-layer, smooth and rough boundaries. Local and average friction coefficients. Separation and Control.		4L
Module 4	Dimensional Analysis and Hydraulic Similitude: Dimensional homogeneity, Rayleigh method, Buckingham's Pi method and other methods. Dimensionless groups. Similitude, Model studies, Types of models. Application of dimensional analysis and model studies to fluid flow problem.		4L
Module 5	Introduction to Open Channel Flow-Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channel flow, Velocity Distribution of channel section.		4L
Module 6	Uniform Flow-Continuity Equation, Energy Equation and Momentum Equation, Characteristics of uniform flow, Chezy's formula, Manning's formula. Factors affecting Manning's Roughness Coefficient "n". Most economical section of channel. Computation of Uniform flow, Normal depth.		3L
Module 7	Non-Uniform Flow- Specific energy, Specific energy curve, critical flow, discharge curve Specific force Specific depth, and Critical depth. Channel Transitions. Measurement of Discharge and Velocity – Venturi Flume, Standing Wave Flume, Parshall Flume, Broad Crested Weir. Measurement of Velocity- Current meter, Floats, Hot-wire anemometer. Gradually Varied Flow-Dynamic Equation of Gradually Varied Flow, Classification of channel bottom slopes, Classification of surface profile, Characteristics of surface profile. Computation of water surface profile by graphical, numerical and analytical approaches. Direct Step method, Graphical Integration method and Direct integration method.		3L
Module 8	Hydraulic Jump- Theory of hydraulic jump, Elements and characteristics of hydraulic jump in a rectangular Channel, length and height of jump, location of jump, Types, applications and location of hydraulic jump. Energy dissipation and other uses, surge as a moving hydraulic jump. Positive and negative surges. Dynamics of Fluid Flow-Momentum principle, applications: Force on plates, pipe bends, moments of momentum equation,		3L
Module 9	Flow through Pipes: Loss of head through pipes, Darcy-Weisbach equation, minor losses, total energy equation, hydraulic gradient line, Pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flows in dead end pipes, siphon, power transmission through pipes, nozzles. Analysis of pipe networks: Hardy Cross method, water hammer in pipes and control measures, branching of pipes, three reservoir problem.		3L
Module 10	Computational Fluid Dynamics: Basic equations of fluid dynamics, Grid generation, Introduction to in viscid incompressible flow, Boundary layer flow as applicable to C.F.D. Hydroinformatics: Concept of hydro informatics –scope of internet and web based modelling in water resources engineering.		3L
Reference	1. Hydraulics and Fluid Mechanics, P.M. Modi and S.M. Seth, Standard Book House 2. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill. 3. Open channel Flow, K. Subramanya, Tata McGraw Hill. 4. Open Channel Hydraulics, VenTe Chow, Tata McGraw Hill. 5. Burnside, C.D., "Electromagnetic Distance Measurement," Beekman Publishers, 1971.		

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CE(PC)503	Structural Engineering	3L + 1T	4 Credits
Module 1	Introduction- concepts of energy principles, safety, sustainable development in performance; what makes a structure; principles of stability, equilibrium; what is a structural engineer, role of engineer, architect, user, builder; what are the functions' what do the engineers design, first principles of process of design		5L
Module 2	Planning and Design Process; Materials, Loads, and Design Safety; Behaviour and Properties of Concrete and Steel; Wind and Earthquake Loads		5L
Module 3	Materials and Structural Design Criteria: Introduction to the analysis and design of structural systems. Analyses of determinate and indeterminate trusses, beams, and frames, and design philosophies for structural engineering. Laboratory experiments dealing with the analysis of determinate and indeterminate structures		8L
Module 4	Design of Structural Elements; Concrete Elements, Steel Elements, Structural Joints; Theories and concepts of both concrete and steel design and analysis both at the element and system levels. Approximate Analysis Methods as a Basis for Design; Design of Reinforced Concrete Beams for Flexure; Design of Reinforced Concrete Beams for Shear; Bond, Anchorage, and Serviceability; Reinforced Concrete Columns; Reinforced Concrete Slabs; Introduction to Steel Design; Tension Members and Connections; Bending Members; Structural Systems		14L
Module 5	System Design Concepts; Special Topics that may be Covered as Part of the Design Project Discussions; Cable Structures; Prestressed Concrete Bridges; Constructability and Structural Control; Fire Protection		10L
Reference	<ol style="list-style-type: none"> 1. Nilson, A. H. <i>Design of Concrete Structures</i>. 13th edition. McGraw Hill, 2004 2. McCormac, J.C., Nelson, J.K. Jr., <i>Structural Steel Design</i>. 3rd edition. Prentice Hall, N.J., 2003. 3. Galambos, T.V., Lin, F.J., Johnston, B.G., <i>Basic Steel Design with LRFD</i>, Prentice Hall, 1996 4. Segui, W. T., <i>LRFD Steel Design</i>, 2nd Ed., PWS Publishing, Boston. 5. Salmon, C.G. and Johnson, J.E., <i>Steel Structures: Design and Behavior</i>, 3rd Edition, Harper & Row, Publishers, New York, 1990. 6. MacGregor, J. G., <i>Reinforced Concrete: Mechanics and Design</i>, 3rd Edition, Prentice Hall, New Jersey, 1997. 7. Nawy, E. G., <i>Reinforced Concrete: A Fundamental Approach</i>, 5th Edition, Prentice Hall, New Jersey. 8. Wang C-K. and Salmon, C. G., <i>Reinforced Concrete Design</i>, 6th Edition, Addison Wesley, New York. 9. Nawy, E. G. <i>Prestressed Concrete: A Fundamental Approach</i>, Prentice Hall, NJ, (2003). 10. Related Codes of Practice of BIS 11. Smith, J. C., <i>Structural Analysis</i>, Harpor and Row, Publishers, New York. 12. W. McGuire, R. H. Gallagher and R. D. Ziemian. "Matrix Structural Analysis", 2nd Edition, John Wiley and Sons, 2000. 13. NBC, <i>National Building Code</i>, BIS (2017). 14. ASCE, <i>Minimum Design Loads for Buildings and Other Structures</i>, ASCE 7-02, American Society of Civil Engineers, Virginia, 2002. 		

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CE(PC)504	Geotechnical Engineering	2L + 1T	3 Credits
Module 1	Introduction–Types of soils, their formation and deposition, Soil as three-phase system in terms of weight & volume. Definitions & Relationship: moisture content, unit weights, degree of saturation, voids ratio, porosity, specific gravity, etc. Determination of Moisture content. Specific gravity, Unit weight.		4 L
Module 2	Plasticity Characteristics of Soil - Consistency limits-liquid limit, plastic limit, shrinkage limit. Determination of: liquid limit, plastic limit and shrinkage limit. Classification of Soils- particle size classification, Indian standard soil classification system.		4 L
Module 3	Permeability: Darcy's law, Determination of co-efficient of permeability, Laboratory method: constant-head method, falling-head method. Field method: pumping. Seepage Analysis-characteristics of flow nets, graphical method to plot flow nets.		4 L
Module 4	Effective Stress Principle - effective stress in soils saturated by capillary action, seepage pressure, quick sand condition.		2 L
Module 5	Compaction of Soil- theory of compaction, laboratory determination of optimum moisture content and maximum dry density. Compaction in field and field control.		2 L
Module 6	Stresses in soils –stresses due to point load, line load, strip load, uniformly loaded circular area, rectangular loaded area. Influence factors, Isobars, Boussinesq's equation, Newmark's Influence Chart.		4 L
Module 7	Consolidation of Soil - initial, primary & secondary consolidation, Terzaghi's theory of consolidation, final settlement of soil deposits, computation of consolidation settlement and secondary consolidation.		4 L
Module 8	Shear Strength - Mohr-Coulomb theory, types of shear tests: direct shear test, triaxial compression tests, pore pressure measurement, unconfined compression test, vane shear test.		4 L
Module 9	Earth pressure theories: Earth pressure at rest, Active & passive earth pressure, Rankine's & Coulomb's earth pressure theories.		4 L
Module 10	Stability of Slopes - types of slopes, factor of safety, analysis of finite and infinite slopes, Swedish and friction circle method, Taylor's stability number.		4 L
Module 11	Soil Exploration- methods of site exploration and soil investigation, methods of boring, soil samplers, sampling procedures, penetrometer tests, analysis of borehole logs.		2 L
Module 12	Introduction to Shallow and Deep foundations: Safe & Allowable bearing capacity, Terzaghi's bearing capacity theory, Bearing capacity as per IS 6403. Pile: Types, Load carrying capacities of piles by static and Dynamic formulae, Pile group: Group efficiency, Negative skin friction.		4 L
Reference	1. An Introduction to Geotechnical Engineering, by Holtz R.D. and Kovacs, W.D., Prentice Hall, NJ 2. Principles of Geotechnical Engineering B. M. Das Thomson Book Store 3. Basic & Applied Soil Mechanics Gopal Ranjan & Willes Eastern Ltd A.S.R.Rao 4. Fundamentals of Soil Engineering by Taylor, John Wiley & Sons 5. Text book of Soil Mechanics & Foundation V.N.S. Murthy CBS Publisher's & Engineering Distributors 6. Essentials of Soil Mechanics and Foundations: Basic Geotechnics by David F. McCarthy 7. Soil Mechanics in Engineering Practice by Karl Terzaghi, Ralph B. Peck, and Gholamreza Mesri. 8. Geotechnical Engineering – Principles and Practice Coduto Pearson Education		

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CE(PC)505	Environmental Engineering	2L + 1T	3 Credits
Module 1	Water: -Sources of Water and quality issues, water quality requirement for different beneficial uses, Water quality standards, water quality indices, water safety plans, Water Supply systems, Need for planned water supply schemes, Water demand industrial and agricultural water requirements, Components of water supply system; Transmission of water, Distribution system, Various valves used in W/S systems, service reservoirs and design. Water Treatment: aeration, sedimentation, coagulation flocculation, filtration, disinfection, advanced treatments like adsorption, ion exchange, membrane processes		12L
Module 2	Sewage- Domestic and Storm water, Quantity of Sewage, Sewage flow variations. Conveyance of sewage- Sewers, shapes design parameters, operation and maintenance of sewers, Sewage pumping; Sewerage, Sewer appurtenances, Design of sewerage systems. Small bore systems, Storm Water- Quantification and design of Storm water; Sewage and Sullage, Pollution due to improper disposal of sewage, National River cleaning plans, Wastewater treatment, aerobic and anaerobic treatment systems, suspended and attached growth systems, recycling of sewage – quality requirements for various purposes.		10L
Module 3	Air - Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution automobile pollution, Chemistry of combustion, Automobile engines, quality of fuel, operating conditions and interrelationship. Air quality standards, Control measures for Air pollution, construction and limitations		6L
Module 4	Noise- Basic concept, measurement and various control methods.		3L
Module 5	Solid waste management- Municipal solid waste, Composition and various chemical and physical parameters of MSW, MSW management: Collection, transport, treatment and disposal of MSW. Special MSW: waste from commercial establishments and other urban areas, solid waste from construction activities, biomedical wastes, Effects of solid waste on environment: effects on air, soil, water surface and ground health hazards. Disposal of solid waste- segregation, reduction at source, recovery and recycle. Disposal methods- Integrated solid waste management. Hazardous waste: Types and nature of hazardous waste as per the HW Schedules of regulating authorities.		4L
Module 6	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.		4L
Module 7	Government authorities and their roles in water supply, sewerage disposal. Solid waste management and monitoring/control of environmental pollution.		3L
Reference	1. Introduction to Environmental Engineering and Science by Gilbert Masters, Prentice Hall, New Jersey. 2. Introduction to Environmental Engineering by P. Aarne Vesilind, Susan M. Morgan, Thompson /Brooks/Cole; Second Edition 2008. 3. Peavy, H.s, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw -Hill International Editions, New York 1985. 4. MetCalf and Eddy. Wastewater Engineering, Treatment, Disposal and Reuse, Tata McGraw-Hill, New Delhi. 5. Manual on Water Supply and Treatment. Ministry of Urban Development, New Delhi. 6. Plumbing Engineering. Theory, Design and Practice, S.M. Patil, 1999 7. Integrated Solid Waste Management, Tchobanoglous, Theissen & Vigil. McGraw Hill Publication 8. Manual on Sewerage and Sewage Treatment Systems, Part A, B and C. Central Public Health and Environmental Engineering Organization, Ministry of Urban Development.		

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CE(PC)506	Transportation Engineering	2L + 0T	2 Credits
Module 1	Highway development and planning-Classification of roads, road development in India, Current road projects in India; highway alignment and project preparation.		4L
Module 2	Geometric design of highways:- Introduction; highway cross section elements; sight distance, design of horizontal alignment; design of vertical alignment; design of intersections, problems		6L
Module 3	Traffic engineering & control- Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control; design of road intersections; design of parking facilities;highway lighting; problems		6L
Module 4	Pavement materials- Materials used in Highway Construction- Soils, Stone aggregates,bituminous binders, bituminous paving mixes; Portland cement and cement concrete: desirableproperties, tests, requirements for different types of pavements. Problems		6L
Module 5	Design of pavements- Introduction; flexible pavements, factors affecting design andperformance; stresses in flexible pavements; design of flexible pavements as per IRC; rigid pavements components and functions; factors affecting design and performance of CC pavements; stresses in rigidpavements; design of concrete pavements as per IRC; problems		8L
Reference	1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017 2. Kadiyalai, L.R., ' Traffic Engineering and Transport Planning', Khanna Publishers. 3. Partha Chakraborty, ' Principles Of Transportation Engineering, PHI Learning, 4. Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski,' Principles of Highway Engineering and Traffic Analysis', 4th Edition, John Wiley 5. Srinivasa Kumar, R, Textbook of Highway Engineering, Universities Press, 2011. 6. Paul H. Wright and Karen K. Dixon, Highway Engineering, 7th Edition, Wiley Student Edition,2009.		

CE(MC)501	Constitution of India/ Essence of Indian Knowledge Tradition	0L + 0T	0 Credits

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CE(PC)591	Hydraulic Engineering	0L + 2P	1 Credits
	<ol style="list-style-type: none"> 1. Flow Visualization 2. Studies in Wind Tunnel 3. Boundary Layer 4. Flow around an Aerofoil / circular cylinder 5. Uniform Flow 6. Velocity Distribution in Open channel flow 7. Venturi Flume 8. Standing Wave Flume 9. Gradually Varied Flow 10. Hydraulic Jump 11. Flow under Sluice Gate 12. Flow through pipes 13. Turbulent flow through pipes 14. Flow visualization 15. Laminar flow through pipes 16. Major losses / Minor losses in pipe 		

CE(PC)592	Structural Engineering	0L + 2P	1 Credits
	<ol style="list-style-type: none"> 1. Design and detailing of a (G+4) residential building and its components only for dead load and live load (w/o wind load, and earthquake load) 2. Design and detailing of a factory shed and its components w/o gantry girder and plate girder 		

CE(PC)593	Geotechnical Engineering	0L + 2P	1 Credits
	<ol style="list-style-type: none"> 1. Field identification of Fine Grained soils and determination of natural moisture content. 2. Determination of Field density by core cutter method & sand replacement method. 3. Determination of specific gravity of soil 4. Grain size distribution of soil by Sieve Analysis and Hydrometer Analysis. 5. Determination of Atterberg's limits (liquid limit, plastic limit & shrinkage limit). 6. Determination of co-efficient of permeability by Constant-head test method & Falling-head method. 7. Determination of compaction characteristics of soil by Standard Proctor test and Modified Proctor test. 8. Determination of compressibility characteristics of soil by Consolidation Test. 9. Determination of Shear parameter of soil by Direct shear test 10. Determination of shear parameter of soil by Triaxial test (UU) 11. Determination of unconfined compressive strength of soil 12. Determination of undrained shear strength of soil by Vane shear test. 13. Determination of Relative density of cohesive soil. 		
Reference	<ol style="list-style-type: none"> 1. Soil Testing by T.W. Lamb (John Willey) 2. SP-36 (Part I-& Part – II) 3. Soil Mechanics Laboratory Manual by Braja Mohan Das, OXFORD UNIVERSITY PRESS 4. Measurement of Engineering properties of soil by E Saibaba Reddy & K. Rama Sastri. (New age International publication). 		

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CE(PC)594	Environmental Engineering	0L + 2P	1 Credits
	1. Physical Characterization of water: Turbidity, Electrical Conductivity, pH 2. Analysis of solids content of water: Dissolved, Settleable, suspended, total, volatile, norganicetc. 3. Alkalinity and acidity, Hardness: total hardness, calcium and magnesium hardness 4. Analysis of ions: copper, chloride and sulfate 5. Optimum coagulant dose 6. Chemical Oxygen Demand (COD) 7. Dissolved Oxygen (D.O) and Biochemical Oxygen Demand (BOD) 8. Break point Chlorination 9. Bacteriological quality measurement: MPN, 10. Ambient Air quality monitoring (TSP, RSPM, SO _x , NO _x) 11. Ambient noise measurement		

CE(PC)595	Transportation Engineering	0L + 2P	1 Credits
	Tests on highway materials – Aggregates- Impact value, Los-Angeles Abrasion value water absorption , Elongation & Flakiness Index. Bitumen & bituminous materials: Specific gravity, penetration value, softening point, loss on heating, Flash & Fire point test. Stripping value test Design of B.C. & S.D.B.C. Mix CBR Test Marshal Stability Test Benkelman beam Test. References: BIS codes on Aggregates & Bituminous materials Highway material testing(Laboratory Manual)by S.K. Khanna and CE.G. Justo Relevant IS & I.R.C. codes.		

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Semester VI [Third year]

CE(PC)601	Construction Engineering & Management	2L + 1T	3 Credits
Module 1	Basics of Construction- Unique features of construction, construction projects- types and features, phases of a project, agencies involved and their methods of execution;		2L
Module 2	Construction project planning- Stages of project planning: pre-tender planning, preconstruction planning, detailed construction planning, role of client and contractor, level of detail.Process of development of plans and schedules, work break-down structure, activity lists, assessmentof work content, concept of productivities, estimating durations, sequence of activities, activityutility data; Techniques of planning- Bar charts, Gantt Charts. Networks: basic terminology, types ofprecedence relationships, preparation of CPM networks: activity on link and activity on noderepresentation, computation of float values, critical and semi critical paths, calendaring networks.PERT- Assumptions underlying PERT analysis, determining three time estimates, analysis, slackcomputations, calculation of probability of completion.		10L
Module 3	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 repetitiveworks; Precast concrete construction methods; Basics of Slip forming for tall structures; Basicconstruction methods for steel structures; Basics of construction methods for Bridges.		6L
Module 4	Construction Equipment basics: Conventional construction methods Vs Mechanizedmethods and advantages of latter; Equipment for Earthmoving, Dewatering; Concrete mixing,transporting & placing; Cranes, Hoists and other equipment for lifting; Equipment for transportationof materials. Equipment Productivities		4L
Module 5	Planning and organizing construction site and resources- Site: site layout includingenabling structures, developing site organization, Documentation at site; Manpower: planning,organizing, staffing, motivation; Materials: concepts of planning, procurement and inventory control; Equipment: basic concepts of planning and organizing; Funds: cash flow, sources of funds; Histograms and S-Curves. Earned Value; Resource Scheduling- Bar chart, line of balance technique, resource constraints and conflicts; resource aggregation, allocation, smoothing and leveling. Common Good Practices in Construction		6L
Module 6	Project Monitoring & Control- Supervision, record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating.Common causes of time and cost overruns and corrective measures. Basics of Modern Projectmanagement systems such as Lean Construction; Use of Building Information Modelling (BIM) inproject management; Quality control: concept of quality, quality of constructed structure, use ofmanuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety, Health and Environment on project sites: accidents; their causes, effects and preventive measures, costs of accidents, occupational health problems in construction, organizing for safety andhealth.		8L
Module 7	Contracts Management basics: Importance of contracts; Types of Contracts, parties to acontract; 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 liquidateddamages; Force Majeure, Suspension and Termination. Changes & variations, Dispute Resolutionmethods.		4L
Module 8	Construction Costs: Make-up of construction costs; Classification of costs, time-costtrade-off in construction projects, compression and decompression.		2L
	1. Varghese, P.C., "Building Construction", Prentice Hall India, 2007. 2. National Building Code, Bureau of Indian Standards, New Delhi, 2017. 3. Chudley, R., Construction Technology, ELBS Publishers, 2007. 4. Peurifoy, R.L. Construction Planning, Methods and Equipment, McGraw Hill, 2011 5. Nunnally, S.W. Construction Methods and Management, Prentice Hall, 2006 6. Jha, Kumar Neeraj., Construction Project management, Theory & Practice, Pearson Education India, 2015 7. Punmia, B.C., Khandelwal, K.K., Project Planning with PERT and CPM, Laxmi Publications, 2016.		

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CE(PC)602	Engineering Economics, Estimation & Costing	2L + 1T	3 Credits
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. Aggregate demand and Supply (IS/LM). Price Indices (WPI/CPI), Interest rates, Direct and Indirect Taxes		3L
Module 2:	Public Sector Economics –Welfare, Externalities, Labour Market. Components of Monetary and Financial System, Central Bank –Monetary Aggregates; Commercial Banks & their functions; Capital and Debt Markets. Monetary and Fiscal Policy Tools & their impact on the economy – Inflation and Phillips Curve.		2L
Module 3	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 4	Indian economy - Brief overview of post-independence period – plans. Post reform Growth, Structure of productive activity. Issues of Inclusion – Sectors, States/Regions, Groups of people (M/F), Urbanization. Employment – Informal, Organized, Unorganized, Public, Private. Challenges and Policy Debates in Monetary, Fiscal, Social, External sectors.		4L
Module 5	<i>Estimation</i> / 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		7L
Module 6	Specifications-Types, requirements and importance, detailed specifications for buildings, roads, minor bridges and industrial structures.		3L
Module 7	Rate analysis-Purpose, importance and necessity of the same, factors affecting, taskwork, daily output from different equipment/ productivity.		3L
Module 8	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		6L
Module 9	Introduction to Acts pertaining to- Minimum wages, Workman's compensation, Contracts, Arbitration, Easement rights.		2L
Reference	<ol style="list-style-type: none"> 1. Mankiw Gregory N. (2002), Principles of Economics, Thompson Asia 2. V. Mote, S. Paul, G. Gupta (2004), Managerial Economics, Tata McGraw Hill 3. Misra, S.K. and Puri (2009), Indian Economy, Himalaya 4. Pareek Saroj (2003), Textbook of Business Economics, Sunrise Publishers 5. M Chakravarty, Estimating, Costing Specifications & Valuation 6. Joy P K, Handbook of Construction Management, Macmillan 7. B.S. Patil, Building & Engineering Contracts 8. Relevant Indian Standard Specifications. 9. World Bank Approved Contract Documents. 10. FIDIC Contract Conditions. 11. Acts Related to Minimum Wages, Workmen's Compensation, Contract, and Arbitration 12. Typical PWD Rate Analysis documents. 13. UBS Publishers & Distributors, Estimating and Costing in Civil Engineering: Theory and Practice including Specification and Valuations, 2016 14. Dutta, B.N., Estimating and Costing in Civil Engineering (Theory & Practice), UBS Publishers, 2016 		

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CE(PE)601A	Geometric Design of Highways	2L + 0T	2 Credits
	<p>Introduction: Classification of rural highways and urban roads.Objectives and requirements of highway geometric design; Design Controls: Topography, vehicle characteristics and design vehicle, driver characteristics, speed, traffic flow and capacity, levels of service, pedestrian and other facilities, environmental factors; Design Elements: Sight distances,Horizontal alignment - design considerations, stability at curves, super elevation, widening, transition curves; curvature at intersections, vertical alignment - grades, ramps, design of summit andvalley curves, combination of vertical and horizontal alignment including design of hair pin bends,design of expressways, IRC standards and guidelines for design problems; Cross Section Elements:Right of way and width considerations, roadway, shoulders, kerbs traffic barriers, medians, frontageroads; Facilities for pedestrians, bicycles, buses and trucks, Pavement surface characteristics - types,cross slope, skid resistance, unevenness; Design Considerations: Design considerations for rural andurban arterials, freeways, and other rural and urban roads; Design Of Intersections: Characteristicsand design considerations of at-grade intersections;; Rotary intersections; Grade separations andinterchanges -; Design of Parking lots</p>		32L

CE(PE)601B	Transport of Water and Wastewater	2L + 0T	2 Credits
	<p>Water Supply Systems: Storage requirements, impounding reservoirs, intake structures, pipe hydraulics, design of distributionsystems, distribution and balancing reservoirs, pipe materials, appurtenances, design for externalloads, maintenance and operation. Sanitary Sewerage Systems: Flow estimation, sewer materials,hydraulics of flow in sewers, sewer lay out, sewer transitions, materials for sewers, appurtenances,manholes, sewer design, conventional and model based design, sewage pumps and pumping stations,corrosion prevention, operation and maintenance, safety.</p> <p>Storm water Drainage Systems: Drainagelayouts, storm runoff estimation, hydraulics of flow in storm water drains, materials, cross sections,design of storm water drainage systems, inlets, storm water pumping, operation and maintenance</p>		32L

CE(PE)601C	Structural Analysis-I	2L + 0T	2 Credits
	Direct stiffness method of structural analysis; fundamentals and algorithms; numerical analysis of plane trusses, grids and frames; virtual work and energy principles; introduction to the finite element method for plane stress and plane strain.		32L

CE(PE)601D	Foundation Engineering	2L + 0T	2 Credits
Module 1	Retaining wall & sheet pile structures: Proportions of retaining walls, stability checks, cantilever and anchored sheet piles, free earth and fixed earth method		6L
Module 2	Site investigation & soil exploration: Planning of sub-surface exploration, methods, sampling, samples, In-situ tests: SPT, SCPT, DCPT, Plate load test. Geo-physical exploration: Seismic refraction and electrical resistivity method. Preparation of bore-log and soil investigation report		6L
Module 3	Shallow foundations : Terzaghi's bearing capacity theory, effect of depth of embedment, water table, eccentricity of load, foundation shape on bearing capacity, Bearing capacity as per IS 6403		6L
Module 4	Settlement analysis of shallow foundation: Immediate and consolidation settlement, correction for rigidity and dimensional effects, settlement in various types of soil, IS-1904 and 8009 recommendations		4L
Module 5	Deep foundations: Pile: Types, load transfer mechanism, Determination of load carrying capacities of piles by static and Dynamic formulae, Recommendations of IS 2911, Pile group: Group efficiency, Negative skin friction, pile load test		6L
Module 6	Foundations on Problematic soils: Problems and Remedies		4L
Reference	<ol style="list-style-type: none"> Principles of Foundation Engineering, B.MDas, Thomson Brook Foundation Analysis and Design, J. E. Bowles, McGraw-Hill Book Company Foundation Engineering by B.C.Chattopadhyay and J.Maity, PHI learning Pvt. Ltd Foundation Engineering N. Som & S. C. Das Codes: Bureau of Indian Standard IS –1904, 6403, 8009, 2950, 2911 		

CE(PE)602A	Pavement Design	2L + 0T	2 Credits
	Introduction: Types and component parts of pavements, Factors affecting designand performance of pavements. Highway and airport pavements.Stresses and Deflections in FlexiblePavements: Stresses and deflections in homogeneous masses. Burmister's two layer theory, threelayer and multi-layer theories; wheel load stresses, various factors in traffic wheel loads; ESWL ofmultiple wheels. Repeated loads and EWL factors; sustained loads.		32L

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	<p>Pavement behaviour under transient traffic loads. Flexible Pavement Design Methods For Highways and Airports: Empirical, semi-empirical and theoretical approaches, development, principle, design steps, advantages; design of flexible pavements as per IRC; Stresses in Rigid Pavements: Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses.</p> <p>Rigid Pavement Design: Types of joints in cement concrete pavements and their functions, joint spacings; design of CC pavement for roads and runways as per IRC, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements; Maintenance, repair and rehabilitation of pavements including design of bituminous and concrete overlays as per IRC</p>	
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CE(PE)602B	Air and Noise Pollution and Control	2L + 0T	2 Credits
	<p>Air pollutants, Sources, classification, Combustion Processes and pollutant emission, Effects on Health, vegetation, materials and atmosphere, Reactions of pollutants in the atmosphere and their effects-Smoke, smog and ozone layer disturbance, Greenhouse effect.</p> <p>Air sampling and pollution measurement methods, principles and instruments, Ambient air quality and emission standards, Air pollution indices, Air Act, legislation and regulations, control principles. Removal of gaseous pollutants by adsorption, absorption, reaction and other methods. Particulate emission control, settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods like absorption, adsorption, precipitation etc. Biological air pollution control technologies, Indoor air quality.</p> <p>Noise pollution: Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; psychoacoustics and noise criteria, effects of noise on health, annoyance rating schemes; special noise environments: Infrasound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoring procedure. Noise indices. Noise control methods</p>		32L

CE(PE)602C	Structural Analysis-II	2L + 0T	2 Credits
	<p>Analysis of building frames; Kani's, moment distribution and other methods and Approximate methods; Stiffness matrix method; Application to simple problems of beams and frames; Flexibility matrix method; Application to simple problems of beams and frames; Moving loads for determinate beams; Different load cases, Influence lines for forces for determinate beams; Influence lines for pin-jointed trusses; Influence lines for indeterminate beams using Muller Breslau principle. Influence lines for Arches and stiffening girders.</p>		34L

CE(PE)602D	Soil Mechanics-II	2L + 0T	2 Credits
Module 1	Earth pressure: Earth pressure theories: Plastic equilibrium of soil, Earth pressure at rest, Active & passive earth pressure, Rankine's & Coulomb's earth pressure theories, wedge method of analysis, estimation of earth pressure by graphical construction (Culmann Method		8L
Module 2	Retaining walls structures, Gravity cantilever and counterfort retaining walls: Stability checks and design. Sheet Pile Structures: Cantilever sheet piling, Anchored sheet piling: Free and fixed earth support methods of Analysis, Analysis of cuts & excavations		10L
Module 3	Stability of slopes: Stability Analysis of Slope: Effective and total stress approach, shape of slip surface, methods of slices, graphic methods, location of critical slip circle, wedge analysis method		8L
Module 4	Soil Anchors: Inclusions and Installation Techniques, Application Criteria: Advantages and Limitations: Instrumentation		6L
Reference	<ol style="list-style-type: none"> Principles of Soil Mechanics, R F Scott, Addison & Wesley Principles of Geotechnical Engineering, Braja M. Das, Cengage Learning Soil Behaviour and Critical State Soil Mechanics, D.M. Wood, University of Glasgow Soil Mechanics by Craig R.F., Chapman & Hall 		

CE(PE)603A	Concrete Technology	2L + 1T	3 Credits
	<p>Concrete; Properties of ingredients, tests, Production of concrete, mixing, compaction curing, Properties of fresh concrete; Defects in Concrete, Concrete additives.; Behavior of concrete in tension and compression, shear and bond, Influence of various factors on test results, Time dependent behavior of concrete -creep, shrinkage and fatigue; Concrete mix design; Proportioning of concrete mixes, basic considerations, cost specifications, factors in the choice of mix proportion, different method of mix design. Quality control, Behavior of</p>		42L

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	concrete in extreme environment; temperature problem in concreting, hot weather, cold weather and under water conditions, Resistance to freezing, sulphate and acid attack, efflorescence, fire resistance; Inspection and testing of concrete- Concrete cracking, types of cracks, causes and remedies Non-destructive tests on concrete; Chemical tests on cement and aggregates; Special concrete; types and specifications, Fibre reinforced and steel Fibre reinforced concrete, Polymer concrete, Use of admixtures; Deterioration of concrete and its prevention Repair and rehabilitation.	
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CE(PE)603B	Soil Mechanics-I	2L + 1T	3 Credits
Module 1	Composition and structure of soil; Fundamental of Soil Structure, Clay Mineralogy		6L
Module 2	Water flow and hydraulic properties; Darcy's law, Permeability of soils, Laboratory and field determination, pumping in and pumping out tests. Flownets -properties and uses. Confined and unconfined flow of water. Flow through earth dam, under hydraulic structures and foundation structures		8L
Module 3	Stress in soil; Stress due to point loads, Stress beneath Line, strip & uniformly loaded circular area & rectangular area, pressure bulbs, Newmark's charts-Use for determination of stress due to arbitrarily loaded areas		6L
Module 4	Compaction and compressibility of soils; One and three dimensional consolidation theories and applications, consolidation characteristics, Immediate and consolidation settlement, settlement analysis		6L
Module 5	Shear strength of soils: Shear strength parameters of cohesion less and saturated cohesive soils, Skempton's Pore pressure coefficients, Basics of unsaturated soils, Experimental measurements		6L
Reference	1. Principles of Soil Mechanics, R F Scott, Addison & Wesley 2. Principles of Geotechnical Engineering, Braja M. Das, Cengage Learning 3. Soil Behaviour and Critical State Soil Mechanics, D.M. Wood, University of Glasgow 4. Soil Mechanics by Craig R.F., Chapman & Hall		

CE(PE)603C	Solid and Hazardous Waste Management	2L + 1T	3 Credits
	Solid Wastes: Origin, Analysis, Composition and Characteristics. Integrated Solid Waste Management System: Collection, Storage, Segregation, Reuse and Recycling possibilities, Transportation, Treatment / Processing and Transformation Techniques, Final Disposal. Management of: Municipal, Biomedical, Nuclear, Electronic and Industrial Solid Wastes and the rules and regulations. Introduction to Hazardous wastes, Definition of Hazardous waste, The magnitude of the problem; Hazardous waste: Risk assessment, Environmental legislation, Characterization and site assessment, Waste minimization and resource recovery, Transportation of hazardous waste, Physical, chemical and biological treatment, Groundwater contamination, Landfill disposal, Current Management Practices, Environmental audit, Pollution Prevention, Facility Development and operation, Site Remediation: Quantitative risk assessment, site and subsurface characterization, Containment, remedial alternatives.		40L

CE(PE)603D	Geographic Information Systems and Science	2L + 1T	3 Credits
	Basic Concepts of GIS : Definition, philosophy & Historical Evolution of GIS; Spatial vs Non-Spatial Data; Components of GIS; Spatial Data Models – Raster and Vector; Data Structure and File Formats; Concepts of RDBMS and Geodatabase. Data Entry and Editing: Sources of Spatial Data (Raster and Vector); Various data input techniques; Datum and Projection; Types of Coordinate Systems; Affine Transformation Spatial Data Analysis-I: Raster Data Analysis – Local, Focal, Zonal and Global Analysis; Vector Data Analysis – Proximity and Overlay Analysis Spatial Data Analysis-II: Spatial Interpolation Techniques; Network Analysis; DEM, DTM and DSM; Difference between 2D, 2.5D, 3D and 4D GIS; Watershed Analysis. GPS and GNSS: Concept of GPS; Satellite Constellations; NAVSTAR GPS Signals; Geopositioning – Concepts, Pseudo Range Measurement, Phase Difference Measurement, Sources of GNSS Errors; Augmentation Systems of IRNSS, GAGAN, WAAS and LAAS. References: 1. Burrough, Peter A. and Rachael McDonnell (1998), „Principles of Geographical Information Systems“ Oxford University Press, New York. 2. George Joseph & C. Jeganathan (2018). Fundamentals of Remote Sensing 3rd edition, Universities Press, India. 3. C.P.Lo and Albert K.W. Yeung (2006). Concepts and Techniques of Geographic Information		40L

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	Systems. Prentice Hall of India, New Delhi. 4. Kang-tsung Chang (2007). Introduction to Geographic Information Systems, Tata McGraw Hill, New Delhi. 5. Satheesh Gopi (2005). Global Positioning System: Principles and Applications. McGraw Hill Publishers. 6. N. Madhu, R. Sathikumar, Satheesh Gopi (2006). Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson India Publisher	
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CE(PE)604A	Pavement Materials	2L + 0T	2 Credits
	Soil - Classification, characteristics, compaction, evaluation of soil strength; stabilized pavement materials; Aggregates: requirements, properties and tests on road aggregates for flexible and rigid pavements. Bitumen: Origin, preparation, properties and tests, constitution of bituminous road binders; requirements; Criterion for selection of different binders. Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests. Bituminous Mixes: Mechanical properties: Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. Bituminous mix design methods and specifications. Weathering and Durability of Bituminous Materials and Mixes. Performance based Bitumen Specifications; Superpave mix design method: design example problems. Cement Concrete for Pavement Construction: Requirements, and design of mix for CC pavement, IRC and IS specifications and tests, joint filler and sealer materials.		34L

CE(PE)604B	Design of Concrete Structures-I	2L + 0T	2 Credits
	Study of the strength, behavior, and design of indeterminate reinforced concrete structures, Load and stresses, load combinations, Working stress and limit state approach. Analysis and design of sections in bending – working stress and limit state method, Rectangular and T-sections, Beams with reinforcement in compression, One-way slab. Design for shear and bond, Mechanism of shear and bond failure, Design of shear using limit state concept, Development length of bars; Design of sections in torsion. Design of two-way slabs; Design of flat slab – direct method; Circular slab; Slab type staircase, Placement of reinforcement in slabs; Voided slab. Design of compression members, Short column, Columns with uni-axial and bi-axial bending; Long columns, use of design charts. Design of foundation; Wall footing, Isolated and combined footing for columns. All designs to be as per the most recent BIS standards as applicable		36L

CE(PE)604C	Environmental Impact Assessment and Life Cycle Analyses	2L + 0T	2 Credits
	Evolution of EIA: Concepts of EIA methodologies, Screening and scoping; Rapid EIA and Comprehensive EIA; General Framework for Environmental Impact Assessment, Characterization and site assessment. Environmental Risk Analysis, Definition of Risk, Matrix Method. Checklist method, Fault tree analysis, Consequence Analysis; Socioeconomic aspects, measures of effectiveness of pollution control activities Environmental Legislation; Introduction to Environmental Management Systems; Environmental Statement - procedures; Environmental Audit: Cost Benefit Analysis; Life Cycle Assessment; Resource Balance, Energy Balance & Management Review; Operational Control; Case Studies on EIA.		30L

CE(OE)601A	Soft Skills and Interpersonal Communication	1L + 1T	2 Credits
Module 1	Self-Introduction	2L	
Module 2	Negotiation Skills & Role Play	4L	
Module 3	J-a-M Session	3L	
Module 4	Building Vocabulary Power through Reading	4L	
Module 5	Group Discussion and Case Study	4L	
Module 6	Writing Skills: Letters, Minutes of Meeting	3L	
Module 7	Technical Report Writing: Concept & Structure	3L	
Module 8	Research Writing: Concept & Structural Framework	3L	
Module 9	Power Point Presentation: Project Presentation	4L	
Module 10	Interviews	5L	

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CE(OE)601B	Introduction to Philosophical Thoughts	1L + 1T	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		3L
Module 3	Samkhya Philosophy: Metaphysics; Theory of Causation. --Prakṛti, Purusa, Evolution; Epistemology		6L
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		4L
Module 5	Nyaya Philosophy : Epistemology -- Perception (Pratyaksa), Inference (Anumāna), Comparison (Upamāna), Testimony (Sabda); Theory of Causation (Asatkāryavāda); Self and Liberation; The Concept of God		9L
Module 6	Mimamsa 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		5L
Module 7	Vaisesika Philosophy: Metaphysics and the Categories -- Substance (Dravya), Quality (Guṇa), Action (Karma), Generality (Sāmānya), Particularity (Vaiśeṣa), Inherence (Samavāya), Non-existence (Abhāva); Epistemology; The Concept of God; Bondage and Liberation		6L
Module 8	Buddhist Philosophy:Epistemology -- Dependent Origination; Four Noble Truths; Eight Fold Paths; Ethics; Karma and Rebirth; Liberation		5L
Module 9	Jaina Philosophy: Syādavāda; Anekāntavāda; Ethics; Karma and Liberation		3L

LABORATORY

CE(PC)691	Engineering Economics, Estimation & Costing	0L + 4L	2 Credits
	1. Deriving an approximate estimate for a multistoried building by approximate methods. 2. Detailed estimate for the following with the required material survey for the same. a. Ground plus three storied RCC Framed structure building with blockwork walls b. bridge with minimum 2 spans c. factory building d. road work e. cross drainage work f. Ground plus three storied building with load-bearing walls g. Cost of finishes, MEP works for (f) above 3. Preparation of valuation report in standard Government form. 4. Assignments on rate analysis, specifications and simple estimates. 5. Detailed estimate of minor structure. 6. Preparation of Bar bending schedule.		

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Semester VII (Fourth year)

CE(PC)701	Hydrology & Water Resources Engineering	2L + 1T	3 Credits
Module	Introduction - hydrologic cycle, water-budget equation, history of hydrology, worldwater balance, applications in engineering, sources of data.		2L
Module 2	Precipitation - forms of precipitation, characteristics of precipitation in India, measurement of precipitation, rain gauge network, mean precipitation over an area, depth-area duration relationships, maximum intensity/depth-duration-frequency relationship, Probable Maximum Precipitation (PMP), rainfall data in India.		5L
Module 3	Abstractions from precipitation - evaporation process, evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods for its reduction, evapotranspiration, measurement of evapotranspiration, evapotranspiration equations, potential evapotranspiration over India, actual evapotranspiration, interception, depression storage, infiltration, infiltration capacity, measurement of infiltration, modelling infiltration capacity, classification of infiltration capacities, infiltration indices.		6L
Module 4	Runoff - runoff volume, SCS-CN method of estimating runoff volume, flow-duration curve, flow-mass curve, hydrograph, factors affecting runoff hydrograph, components of hydrograph, base flow separation, effective rainfall, unit hydrograph surface water resources of India, environmental flows.		6L
Module 5	Ground water and well hydrology - forms of subsurface water, saturated formation, aquifer properties, geologic formations of aquifers, well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifers, aquifer tests.		5L
Module 6	Water withdrawals and uses – water for energy production, water for agriculture, water for hydroelectric generation; flood control. Analysis of surface water supply, Water requirement of crops-Crops and crop seasons in India, cropping pattern, duty and delta; Quality of irrigation water; Soil-water relationships, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation; Methods of applying water to the fields: surface, sub-surface, sprinkler and trickle / drip irrigation.		6L
Module 7	Distribution systems - canal systems, alignment of canals, canal losses, estimation of design discharge. Design of channels- rigid boundary channels, alluvial channels, Kennedy's and Lacey's theory of regime channels. Canal outlets: non-modular, semi-modular and modular outlets. Water logging: causes, effects and remedial measures. Lining of canals, types of lining. Drainage of irrigated lands: necessity, methods.		6L
Module 8	Dams and spillways - embankment dams: Classification, design considerations, estimation and control of seepage, slope protection. Gravity dams: forces on gravity dams, causes of failure, stress analysis, elementary and practical profile. Arch and buttress dams. Spillways: components of spillways, types of gates for spillway crests; Reservoirs- Types, capacity of reservoirs, yield of reservoir, reservoir regulation, sedimentation, economic height of dam, selection of suitable site.		6L
Reference	1. K Subramanya, Engineering Hydrology, Mc-Graw Hill. 2. K N Muthreja, Applied Hydrology, Tata Mc-Graw Hill. 3. K Subramanya, Water Resources Engineering through Objective Questions, Tata Mc-Graw Hill. 4. G L Asawa, Irrigation Engineering, Wiley Eastern 5. L W Mays, Water Resources Engineering, Wiley. 6. J D Zimmerman, Irrigation, John Wiley & Sons 7. C S P Ojha, R Berndtsson and P Bhunya, Engineering Hydrology, Oxford.		

CE(PC)702	Disaster Preparedness & Planning	1L + 1T	2 Credits
Module 1	Introduction - Concepts and definitions: disaster, hazard, vulnerability, risks- severity, frequency and details, capacity, impact, prevention, mitigation).		2L
Module 2	Disasters - Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility.		6L
Module 3	Disaster Impacts - Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.		6L
Module 4	Disaster Risk Reduction (DRR) - Disaster management cycle – its phases; 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 programmes in India and the activities of National Disaster Management Authority.		8L

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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
Reference	1. http://ndma.gov.in/ (Home page of National Disaster Management Authority) 2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs). 3. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall. 4. Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication. 5. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation 6. Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California, EMSA no.214, June 2003 7. Inter Agency Standing Committee (IASC) (Feb. 2007). IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings. Geneva: IASC	

CE(PE)701A	Airport Planning and Design	2L + 1T	3 Credits
	Aircraft characteristics; Aircraft performance characteristics: Airport planning and air travel demand forecasting; Airport Site Selection; Geometric Design of the Airfield: Determination of Runway Capacity and Delay - Taxiway and Gate Capacity - Holding Aprons - Terminal Aprons - Airport drainage - Function of Airport Passenger and Cargo Terminal - Design of Air Freight Terminals - Airport access - Airport Landside planning - Capacity; Air Traffic Management: Navigational aids: ground based systems, satellite based systems - Air traffic control and surveillance facilities - Airfield lighting - air traffic management.		36L

CE(PE)701B	Design of Steel Structures	2L + 1T	3 Credits
	Properties of materials; loads and stresses, Design of semi-rigid, rigid and moment resistant connections; Built-up sections Design of tension members subjected to axial tension and bending, splicing of tension member, Design of compression members, Beam-column connections, Design of columns and their bases Design of flexural members and Plate girder; loads, specification and design Industrial buildings; loads, design of purlins, trusses, bracings; gantry girders; Introduction to Plastic analysis; Simple cases of beams and frames; All design steps/processes as per the most recent BIS code of practices		42L

CE(PE)701C	Groundwater Engineering	2L + 1T	3 Credits
	The main objective is to provide sufficient knowledge to the students about the groundwater hydrology, well hydraulics and well construction, geo-physical explorations, groundwater quality and management of groundwater resources; Problems and perspectives regarding groundwater in India; Hydrogeology: Darcy's Equation; flow characteristics; general flow equations; unsaturated flow; Well Hydraulics: Steady and unsteady radial flows in aquifers; partially penetrating wells; multiple well systems; characteristic well losses; specific capacity, Surface and Subsurface investigations (Geologic methods; remote sensing; geophysical explorations; electrical resistivity and seismic refraction), Water Wells: Construction; completion, development, protection and rehabilitation of wells; Groundwater quality; Groundwater Management: Basin management, investigations, conjunctive use, modeling, artificial recharge; Saline water intrusion		42L

GROUND IMPROVEMENT TECHNIQUES.

Code – CE(PE)701D

Contact – 2L +1T

Credits-3

Module	Details of Course Content	Hours	Total
1	Introduction, Stabilization of soil with granular skeleton and soil without granular skeleton, soil stabilization: Stabilization with cement, lime fly-ash	6	32
2	Densification of granular soil: Vibration at ground surface, Vibration at depth (Vibroflotation), ground modification by vibro-replacement	4	
3	Densification of Cohesive Soils: preloading and prefabricated drains and stone	6	

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	columns		
4	Reinforced earth structures, Introduction to Geotextiles and geomembranes, applications of geotextiles, design methods using geotextiles, geogrids, geonets, geomembranes, geotubes	6	
5	Grouting: Over view: Suspension and Solution grout, Grouting equipment and methods, Grout design and layout, deep mixing, PVDs, vacuum consolidation	6	
6	Soil stability: Soil nailing, Soil and Rock Anchors, Underpinning	4	

Reference books:

1. Principles and Practice of Ground Improvement by Jie Han
2. Ground Improvement Techniques by B.C.Chattopadhyay and J.Maity, PHI learning Pvt. Ltd.
3. Foundation Design Manual N. V. Nayak, Dhanpat Rai Publication Pvt. Ltd
4. Ground Improvement Techniques by P. Purushothama Raj
5. Reinforced Earth T S Ingold Thoam Telford
6. Designing with Geosynthetics R M Koerner Prentice Hall

CE(PE)701E	Ecological Engineering	2L + 1T	3 Credits
	<p>River/Lake water pollution: DO, 5 day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river[deoxygenation, reaeration]; COD; Eutrophication [Definition, source and effect].</p> <p>Wastewater Types and Characteristics: Difference between domestic and industrial waste water; Sources & classification of domestic & industrial Wastewater, Physical, chemical and biological characteristics of domestic and industrial wastewater; Indian Standards for effluent disposal and receiving water body; Disposal of treated wastewaters; Effect of organic pollution on river water quality.</p> <p>Wastewater Treatment: Typical flow chart for wastewater treatment; Primary Treatments; Secondary Treatments: Activated Sludge Process, Trickling Filter Process, Septic Tank.</p> <p>Chemical Hazards and Biomonitoring: Causes and effects of chemical hazards; Concepts, Methods, Advantages and Limitations of Bio-monitoring and surveillance; Categories and practical use of Biological Indicators.</p> <p>Effluent Monitoring: Basic principles of environmental laws; Role of regulatory bodies& Local bodies-CPCB-TWAD Board-CMWSSB, SPCB etc.; Standards for Effluent Discharge in India</p> <p>References:</p> <ol style="list-style-type: none"> 1.Garg .S.K., “Environmental Engineering”, Vol. I, Khanna Publishers, New Delhi, 2014. 2.Duggal .K.N, “Elements of Environmental Engineering”, S. Chand & Company Ltd., New Delhi, 2012. 3. Chatterjee, A.K., “Water Supply, Waste Disposal and Environmental Pollution Engineering”, Khanna Publishers, New Delhi, 2014. 		38L

CE(PE)702A	Intelligent Transportation Systems	2L + 1T	3 Credits
	<p>Introduction to Intelligent Transportation Systems (ITS) –Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS – ITSData collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.Telecommunications in ITS – Importance of telecommunications in the ITS system, InformationManagement, Traffic Management Centres (TMC). Vehicle – Road side communication – VehiclePositioning System; ITS functional areas – Advanced Traffic Management Systems (ATMS),Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), AdvancedVehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), AdvancedRural Transportation Systems (ARTS); ITS User Needs and Services – Travel and Trafficmanagement, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management;</p> <p>Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems.ITS Programs in the World – Overview of ITS implementations in developed countries, ITS indeveloping countries.</p>		40L

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CE(PE)702B	Water and Air Quality Modelling	2L + 1T	3 Credits
	Introduction to Mathematical Models: water quality model development, calibration and verification cost: benefit analysis using models, Model requirements and limitations. D.O. Models for Streams: 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- Benthic oxygen demand mass transport mechanisms- Models for Estuary and Lakes: Physical chemical and biological processes in estuaries; Air quality models: Micrometeorological processes, wind rose, dispersion, coefficients and stability classes, Gaussian and dispersion model, Stack height computation, Regional air quality models, Source inventories and significance .		40L

CE(PE)702C	Earthquake Engineering	2L + 1T	3 Credits
	Theory of Vibrations; Concept of inertia and damping - Types of Damping - Difference between static forces and dynamic excitation - Degrees of freedom – SDOF idealization - Equations of motion of SDOF system for mass as well as base excitation – Free vibration of SDOF system - Response to harmonic excitation - Impulse and response to unit impulse - Duhamel integral; Multiple Degree of Freedom System; Two degree of freedom system – Normal modes of vibration - Natural frequencies - Mode shapes - Introduction to MDOF systems - Decoupling of equations of motion - Concept of mode superposition (No derivations); Elements of Seismology; Causes of Earthquake - Geological faults - Tectonic plate theory - Elastic rebound – Epicentre; Hypocentre - Primary, shear and Rayleigh waves - Seismogram - Magnitude and intensity of earthquakes - Magnitude and Intensity scales - Spectral Acceleration - Information on some disastrous earthquakes; Response of Structures to Earthquake; Response and design spectra – Design earthquake - concept of peak acceleration - Site specific response spectrum - Effect of soil properties and damping - Liquefaction of soils - Importance of ductility - Methods of introducing ductility into RC structures Design Methodology IS 1893, IS 13920 and IS 4326 - Code provisions - Design as per the codes - Base isolation techniques - Vibration control measures - Important points in mitigating effects of earthquake on structures		42L

CE(PE)702D	Prestressed Concrete	2L + 1T	3 Credits
	Study of strength, behavior, and design of prestressed reinforced concrete members and structures, with primary emphasis on pretensioned, precast construction; emphasis on the necessary coordination between design and construction techniques in prestressing.		40 L

CE(OE)701A	Metro Systems & Engineering	3L + 0T	3 Credits
Module 1	General: Overview of Metro Systems; Need for Metros; Routing studies; Basic Planning and Financials		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- Signalling systems; Automatic fare collection; Operation Control Centre (OCC and BCC); SCADA and other control systems; Platform Screen Doors		9L
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		9L
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		8L

CE(OE)701B	ICT for Development	3L + 0T	3 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		10L
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		8L

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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	10L
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 journalism; wiki journalism; open source journalism; citizen journalism; back-pack journalism, Convergent technologies and applications; Multimedia convergence and Interactivity	14L

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Semester VIII (Fourth year]

CE(HS)801	Professional Practice, Law & Ethics	2L + 0T	2 Credits
Module 1 A	Professional Practice – Respective roles of various stakeholders: Government(constituting regulatory bodies and standardization organizations, prescribing norms to ensure safetyof 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 bycontracts and regulatory Acts and Standards); Manufacturers/ Vendors/ Service agencies (rolegoverned by contracts and regulatory Acts and Standards)		2 L
Module 1 B	Professional Ethics – Definition of Ethics, Professional Ethics, Business Ethics,Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website ofInstitution 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.		2 L
Module 2	General Principles of Contracts Management: Indian Contract Act, 1972 andamendments covering General principles of contracting; Contract Formation & Law; Privacy ofcontract; Various types of contract and their features; Valid & Voidable Contracts; Prime and subcontracts;Joint Ventures & Consortium; Complex contract terminology; Tenders, Request ForProposals, Bids & Proposals; Bid Evaluation; Contract Conditions & Specifications; Critical /“RedFlag” 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; Wrongpractices in contracting (Bid shopping, Bid fixing, Cartels); Reverse auction; Case Studies; Build-Own-Operate & variations; Public- Private Partnerships; International Commercial Terms;		18 L
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 commercialarbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures bycourt; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for settingaside an award, Enforcement, Appeal and Revision; Enforcement of foreign awards – New York andGeneva Convention Awards; Distinction between conciliation, negotiation, mediation andarbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; LokAdalats.		5 L
Module 4	Engagement of Labour and Labour & other construction-related Laws: Role of Labourin 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 ofemployment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017		2 L
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;		1 L
	1. B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974. 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. NeelimaChandiramani (2000), The Law of Contract: An Outline, 2nd Edn. Avinash PublicationsMumbai 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 UNCITRALModel Law on Arbitration, Indian Council of Arbitration 10. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co. 11. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House 12. Bare text (2005), Right to Information Act		

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	<p>13. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers 14. K.M. Desai(1946), The Industrial Employment (Standing Orders) Act 15. Rustamji R.F., Introduction to the Law of Industrial Disputes, Asia Publishing House 16. Vee, Charles & Skitmore, Martin (2003) Professional Ethics in the Construction Industry, Engineering Construction and Architectural management, Vol.10, Iss2, pp 117-127, MCB UP Ltd 17. American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application 18. Ethics in Engineering- M.W.Martin&R.Schinzinger, McGraw-Hill 19. Engineering Ethics, National Institute for Engineering Ethics, USA 20. www.ieindia.org 21. Engineering ethics: concepts and cases – C. E. Harris, M.S. Pritchard, M.J.Rabins 22. CONSTRUCTION CONTRACTS, http://www.jnormanstark.com/contract.htm 23. Internet and Business Handbook, Chap 4, CONTRACTS LAW, http://www.laderapress.com/laderapress/contractsawl.html 24. Contract & Agreements http://www.tco.ac.ir/law/English/agreements/General/Contract%20Law/C.htm 25. Contracts, http://206.127.69.152/jgretch/crj/211/ch7.ppt 26. Business & Personal Law. Chapter 7. “How Contracts Arise”, http://yucaipahigh.com/schristensen/lawweb/lawch7.ppt 27. Types of Contracts, http://cmsu2.cmsu.edu/public/classes/rahm/meiners.con.ppt 28. IV. TYPES OF CONTRACTS AND IMPORTANT PROVISIONS, http://www.worldbank.org/html/opr/consult/guidetxt/types.html 29. Contract Types/Pricing Arrangements Guideline- 1.4.G (11/04/02), http://www.sandia.gov/policy/14g.pdf</p>	
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CE(PE)801A	Structural Dynamics	2L + 1T	3 Credits
	Analysis of the dynamic response of structures and structural components to transient loads and foundation excitation; single-degree-of-freedom and multi-degree-of-freedom systems; response spectrum concepts; simple inelastic structural systems; and introduction to systems with distributed mass and flexibility.		42L

CE(PE)801B	Contracts Management	2L + 1T	3 Credits
	Contract Management – Introduction, Importance of Contracts, Overview of Contract Management, Overview of Activities in Contract Management; Planning and People-Resource Management; Types of Contracts, Parties to a Contract; Contract Formation, Formulation of Contract, Contract Start-Up, Managing Relationships; 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, Notices under contracts; Conventional and Alternative Dispute Resolution methods. Various Acts governing contracts; Contract Administration and Payments- Contract Administration, Payments; Contract Management in Various Situations Contract Management in NCB Works, Contract Management in ICB Works Contracts, Contract of Supply of Goods- Design, Supply and Installation Contracts, Contract Management in Consultancy, Managing Risks and Change- Managing Risks, Managing Change; Contract Closure and Review- Ending a Contract, Post-Implementation Review; Legal Aspects in Contract Management- Contract Management Legal View, Dispute Resolution, Integrity in Contract Management; Managing Performance- Introduction, Monitoring and Measurement		40L

CE(PE)801C	Traffic Engineering and Management	2L + 1T	3 Credits
	Traffic Forecast: General travel forecasting principles, different methods of traffic forecast - Mechanical and analytical methods, Demand relationships, methods for future projection; Design Hourly Volume For Varying Demand Conditions: Concept of Design vehicle units and determination of PCU under mixed traffic conditions, Price-volume relationships, demand functions. Determination of design hourly volume; critical hour concept; Highway Capacity: Factors affecting capacity, level of service; Capacity studies – Capacity of different highway facilities including unsignalised and signalised intersections. Problems in Mixed Traffic flow; Case studies; Accident Analysis: Analysis of individual accidents and statistical data; Methods of representing accident rate; Factors in traffic accidents; influence of roadway and traffic conditions on traffic safety; accident coefficients; Driver strains due to roadway and traffic conditions; Traffic Flow Theory: Fundamental flow relationship and their applications, Traffic flow theories and applications; Shock waves; Queuing theory and applications; Probabilistic Aspects Of Traffic Flow: Vehicle arrivals, distribution models, gaps and headway distribution models; gap acceptance merging parameters, delay models,		42L

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	applications; Simulation: Fundamental principle,application of simulation techniques in traffic engineering - formulation of simulation models, Casestudies. Formulation of system models.	
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ROCK MECHANICS

Code – CE(PE)801D

Contact – 2L+1T

Credits-3

Module	Details of Course Content	Hours	Total
1	Composition of rocks, Engineering classification and Limitation of Geologic classification of rocks.	6	32
2	Rock coming, various methods of obtaining rock cores, Engineering Properties of rock, stress -strain relations, elastic theory application to design in rock.	6	
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.	8	
4	Measurement of stresses -rock mass, various types of measuring devices, evaluation of properties of rocks in the field.	6	
5	Strain and displacement of the rock mass, rock reinforcement and support, subsidence.	6	

Text Books:

1. Engineering Rock Mechanics: An Introduction to the Principles by J. A. Hudson and J. P. Harrison
2. Rock Mechanics: For Underground Mining by Barry H.G.
3. Empirical Rock Failure Criteria, P.R. Sheorey, Balkema, Rotterdam, 1997
4. Rock Mechanics in Engineering Practice, K.G.Stagg and O.C.Zienkiewicz, John Wiley and Sons, London.
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.
8. Brady Introduction to Rock Mechanics, R. E. Goodman,
9. Fundamentals of Rock Mechanics, 4th Edition, John Conrad Jaeger, Neville G. W. Cook, Robert Zimmerman

CE(PE)801E	Physico-Chemical Process for Water & Wastewater Treatment	2L + 1T	3 Credits
	The Objective of this course is to provide an in depth understanding of physical and physico-chemical processes used for water and wastewater treatment systems and to provide capability to design such systems. Water purification in natural systems, physical processes, chemical processes and biological processes. Primary, secondary and tertiary treatment. Unit operations, unit processes. Aeration and gas transfer. Sedimentation, different types of settling, sedimentation tank design. Coagulation and flocculation, coagulation processes, stability of colloids, destabilization of colloids, destabilization in water and wastewater treatment, transport of colloidal particles, design aspects. 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, pre-coat filtration, design aspects. Disinfection: Types of disinfectants, Kinetics of disinfection, chlorination and its theory, Design of Chlorinators. Precipitation: Hardness removal, Iron, Mn, and heavy metal removal; Adsorption, adsorption equilibria and adsorption isotherm, rates of adsorption, Sorption kinetics in batch reactors, continuous reactors, factors affecting adsorption. Ion Exchange-exchange processes, materials and reactions, methods of operation, Application, design aspects. Membrane Processes, Reverse		

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osmosis, Ultrafiltration, Electrolysis
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CE(PE)802A	Reliability Analysis of Structures	2L + 0T	2 Credits
	Role of reliability in civil engineering; Historical background, random events, random variables, model uncertainty; Common probabilistic models; Important statistical parameters and their estimations, normal, lognormal, extreme value distribution; Fundamental concept of structural reliability; Derivation of stress-strength interface equation, graphical representation, Cornell reliability index, reliability and failure probability computations for simple linear functions; Second moment concepts, First order second moment theory, Hasofer-Lind transformation, Linear and non-linear limit state functions, Solution schemes, geometric interpretation of solution scheme, Rackwitz-Fiessler transformation, First order reliability method; Stochastic models for material strength and loads, Reliability assessment of structural component and simple civil engineering structures.		32L

CE(PE)802B	Railway Engineering	2L + 0T	2 Credits
	Railway track gauge, alignment of railway lines, engineering surveys and construction of new lines, tracks and track stresses; rails, sleepers; ballast; subgrade and formation, rack fittings and fastenings, creep of rails, geometric design of track, curves and super-elevation, points and crossings, track junctions and simple track layouts; rail joints and welding of rails; track maintenance, track drainage; modern methods of track maintenance, rehabilitation and renewal of track; tractive resistance and power, railway stations and yards; railway tunneling; signaling and interlocking; maintenance of railways and high speed trains.		32L

CE(PE)802C	Environmental Laws and Policy	2L + 0T	2 Credits
	Overview of environment, nature and eco system, Concept of laws and policies, Origin of environmental law, Introduction to environmental laws and policies, Environment and Governance, sustainable development and environment, understanding climate change, carbon crediting, carbon foot print etc., Introduction to trade and environment. International environmental laws, Right to Environment as Human Right, International Humanitarian Law and Environment, environment and conflicts management, Famous international protocols like Kyoto.		30L

ENVIRONMENTAL GEOTECHNOLOGY.

Code – CE(PE)802D

Contact – 2L

Credits-2

Module	Details of Course Content	Hours	Total
1	Soil and ground water pollutants -their sources, nature, composition and polluting effects.	6	32
2	The physico-chemical aspects of soils contaminated by various pollutants.	4	
3	Effects of environment and wastes on the properties of soils.	4	
4	Solid and liquid wastes disposal method and management, land treatment systems.	6	
5	Man made changes in geotechnical environment -mining, embankments, pumping, reservoir, landfills and reclamation effects and control.	6	
6	Control of contamination with use of clay barriers, geosynthetics, cut-off walls, leachate collection systems. Stabilization -different materials and techniques in control of ground pollution and treatment.	6	

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CE(OE)801A	Human Resource Development and Organizational Behaviour	3L + 0T	3 Credits
Module 1	Introduction to HRM and Organizational Behaviour (OB): Human resource management (HRM) at work: Definition – HR Challenge –Management process, Changing environment of Human Resource Management: Work force diversity, Technological trends – Globalization, Strategic planning and HR today: Nature of strategic planning – Building competitive advantage – Human resource as a source of competitive advantage, Definition of organizational behavior (OB) and historical development: Definition –Goals of OB – Challenges and opportunities, OB in a global context: The global economy – Facing the international challenge – Behaviour across cultures		6L
Module 2	Understanding and managing individual behavior: Foundation of individual behaviour: Biographical characteristics – Ability – Learning – Implication for performance and satisfaction, Values and attitudes: Importance of values – Types of values – Types of attitude –Attitude and consistency, Perception: Defining perception and its importance – Factors influencing perception, Personality & emotions: Personality determinants – Personality traits – Major personality attributes influencing OB, Emotional intelligence: Defining emotions – The six universal emotions – Emotions and national culture – OB applications, Individual decision making: The rational decision-making process – Improving creativity in decision making – Identifying problems – Ethics in decision making		6L
Module 3	Understanding and managing group behaviour: Defining & classifying groups: Formal group – Informal group – Command group – Task group – Interest group, Basic group concepts: Roles – Norms – Cohesiveness – Size – Composition – Status, Group decision making: Individual vs. group – Group decision making techniques, Understanding work teams: Team versus groups – Types of teams – Cross functional teams – Creating effective teams, Conflict and inter-group behaviour: Definition of conflict – Transitions in conflict thought – The conflict process – Intergroup relations		4L
Module 4	Recruitment and placement: Nature of job analysis: Definition – Uses of job analysis information, Steps in job analysis, Methods of collecting job analysis information: Interview – Questionnaires –Observation – Quantitative job analysis techniques, Job description and specification: Job identification – Responsibilities and duties – Specification for trained versus untrained personnel, Recruitment and selection process: Introduction – Advertising – Employment agencies – Selection process – Basic testing concepts, Human resource planning and forecasting: Employment planning and forecasting – Factors in forecasting personnel needs – Forecasting supply of inside candidates – Recruiting job candidates		4L
Module 5	Training and development:Building employee commitment – Orientation and socialization, Training needs analysis: Task analysis – Performance analysis – Setting training objectives, Training techniques: On-the-job training – Job instruction training – Audiovisual techniques – Programmed learning, Information technology and HR – Training via the internet, Nature and purpose of management development: Definition – Succession planning, Job rotation and management: Coaching – Action learning – Advantage, Performance management & appraisal: Appraisal process – Appraisal methods – Problems and solutions – Role of appraisals in managing performance, Using HR to build a responsive learning organization: HR and systematic problem solving – Learning from experience – Transferring knowledge		6L
Module 6	Compensation and retention: Basic aspects of compensation: Compensation at work – Legal considerations in Compensation, Pricing managerial and professional jobs: Basic compensation elements – Compensating professional employees, Current trends and issues in compensation: Skill-based pay – Broad banding, Comparable worth – Pay secrecy – Inflation and salary compression, Financial incentives: Use of financial incentives – Types of incentive plans, Retirement benefits: Social security – Pension plans – Other retirement benefits, Employee service benefits: Job-related service benefits – Executive perquisites – Law for working women, Retention of employees: Definition – Strategy – Benefits		4L
Module 7	Labour relations & legislation:The labour movement, unions and the law: Introduction – Why do workers organize – Background – Labour law today, Guaranteed fair treatment and employee discipline: GFTP at work – Fairness in disciplining – Discipline guidelines – Discipline without punishment, Managing dismissals: Definition – Grounds for dismissal – Dismissal procedure, Salient provisions under Indian Factories Act: Labour issues – Factory Act 1948, Industrial Disputes Act: Objective – Applicability, Employees State Insurance Act: Definition – Commencement		4L

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	and application, Workmen's Compensation Act: Definition – Employer's liability for compensation, Payment of Bonus Act: Applicability – Eligibility – Benefits	
Module 8	Global HRM & Organizational development (OD): Nature of global HRM: Strategic overview – HR and the international business – HR challenges of international business, Multinational and global corporations: Market imperfections – International power – Criticisms of multinationals, The expatriate manager in multinational corporations: Introduction – Selecting the expatriate manager – Training, OD values and outcomes: Respect for people – Trust and support – Power equalization – Confrontation, Implementation issues in OD and difference in organizational cultures: Improved organizational effectiveness – Greater commitment and involvement – Increased personal and organizational awareness	4L
Reference	<ol style="list-style-type: none"> Organizational Behavior-Stephen P. Robbins, Prentice-Hall of India, New Delhi Human Resource Management- Gary Dessler, Pearson Education Human Resource Management- Cynthia D. Fisher, Schoenfeldt & Shaw, Biztantra, New Delhi 	

CE(OE)801B	History of Science & Engineering	3L + 0T	3 Credits
Module 1	Science and Technology- The Beginning: Development in different branches of Science in Ancient India: Astronomy, Mathematics, Engineering and Medicine; Developments in metallurgy: Use of Copper, Bronze and Iron in Ancient India; Development of Geography: Geography in Ancient Indian Literature		8L
Module 2	Developments in Science and Technology in Medieval India: Scientific and Technological Developments in Medieval India; Influence of the Islamic world and Europe; The role of makhtabs, madrasas and karkhanas set up; Developments in the fields of Mathematics, Chemistry, Astronomy and Medicine; Innovations in the field of agriculture - new crops introduced new techniques of irrigation etc		8L
Module 3	Developments in Science and Technology in Colonial and Independent India: Early European Scientists in Colonial India- Surveyors, Botanists, Doctors, under the Company's Service; Indian Response to new Scientific Knowledge, Science and Technology in Modern India; Development of research organizations like CSIR and DRDO; Establishment of Atomic Energy Commission; Launching of the space satellites and Development of ISRO		12L
Module 4	Prominent scientist of India since beginning and their achievement: Mathematics and Astronomy: Baudhayan, Aryabhata, Brahmgupta, Bhaskaracharya, Varahamihira, Nagarjuna; Medical Science of Ancient India (Ayurveda & Yoga): Susruta, Charak, Yoga & Patanjali; Scientists of Modern India: Srinivas Ramanujan, C.V. Raman, Jagdish Chandra Bose, Acharya Prafulla Chandra Roy, Satyendra Nath Bose, Meghnad Saha, Homi Jehangir Bhabha and Dr. Vikram Sarabhai		14L
Reference	<ol style="list-style-type: none"> Binod Bihari Satpathy. "History of Science and Technology in India". Development. Volume 29. G. Kuppuram. 1990. "History of Science and Technology in India". South Asia Books. M. Bhardwaj. 2010. "History of Science and Technology in Ancient India". Bookwin 		

CE(OE)802A	Economic Policies in India	2L + 0T	2 Credits
Module 1	Framework of Indian Economy: National Income: Trends and Structure of National Income; Demographic Features and Indicators of Economic Growth and Development Rural-Urban Migration and issues related to Urbanization; Poverty debate and Inequality, Nature, Policy and Implications; Unemployment-Nature, Central and State Government's policies, policy implications, Employment trends in Organized and Unorganized Sector		6L
Module 2	Development Strategies in India: Agricultural- Pricing, Marketing and Financing of Primary Sector; Economic Reforms- Rationale of Economic Reforms, Liberalization, Privatization and Globalization of the Economy; Changing structure of India's Foreign Trade; Role of Public Sector- Redefining the role of Public Sector, Government Policy towards Public Sector, problems associated with Privatization, issues regarding Deregulation-Disinvestment and future of Economic Reforms		8L
Module 3	The Economic Policy and Infrastructure Development: Energy and Transport; Social Infrastructure- Education, Health and Gender related issues, Social Inclusion; Issues and policies in Financing Infrastructure Development; Indian Financial System- issues of Financial Inclusion, Financial Sector Reforms-review of Monetary Policy of R.B.I. Capital Market in India.		12L
Module 4	The Economic Policy and Industrial Sector: Industrial Sector in Pre-reforms period, Growth and Pattern of Industrialization; Industrial Sector in Post-reform period- growth and pattern of Micro, Small, Medium Enterprises s, problems of India's Industrial Exports; Labour Market-issues in Labour Market Reforms and approaches to Employment Generation		6L

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Reference	<ol style="list-style-type: none"> 1. Brahmananda, P.R. and V.A. Panchmukhi.[2001], Ed. 'Development Experience in Indian Economy, Inter-state Perspective,' Bookwell, New Delhi. 2. Gupta,S.P.[1989], 'Planning and Development in India: A Critique,' Allied Publishers Private Limited, New Delhi. 3. Bhagwati, Jagdish.[2004], 'In Defense of Globalization,' Oxford University Press, U.K. 4. Dhingra, Ishwar //C.[2006], 'Indian Economy,' Sultan Chand and Sons, New Delhi. 5. Datt, Ruddar and Sundaram, K.P.M.[Latest edition] , 'Indian Economy,' S. Chand and Co, New Delhi. 	
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CE(OE)802B	Cyber Law and Ethics	2L + 0T	2 Credits
Module 01	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 02	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		8L
Module 03	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		8L
Module 04	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 05	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	<ol style="list-style-type: none"> 1. Computer Ethics-Deborah G. Johnson, Pearsons Education 2. Cyber Law Simplified-VivekSood, 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 5. Principles of Information Security- Michael E. Whitman, Herbert J. Mattord, Course Technology 		