VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

(VJTI)

MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)

For
Final Year Syllabus
Bachelor of Technology (B.Tech.) Degree in Civil Engineering

Implemented from the batch admitted in Academic Year 2023-24

[NEP 2020 Based syllabus]

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Program Educational Objective

PEO1	Develop a professional to pursue career as a Civil Engineer with adequate technical knowledge and skills while using modern tools for problem solving and exhibiting qualities of communication, team membership, and leadership
PEO2	Develop ability to practice ethically focusing on social relevance, environmental sustainability, optimal solutions and safety of stakeholders.
PEO3	Develop abilities of lifelong learning to continuously strive to enhance decision making abilities to investigate, design and develop complex facilities.

Program Specific Outcomes

PSO1	Able to analyze various Civil Engineering structures and systems by using basic and advanced technologies.
PSO2	Able to design civil engineering facilities and their elements and also use of modern software tools for the same.
PSO3	Able to plan, monitor and supervise construction activities to complete civil engineering facilities satisfactorily.
PSO4	Able to practice as a construction professional through ethical practice while focusing on sustainability and economy.

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Program Outcomes

PO-1	**Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.
PO-2	**Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.
PO-3	**Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required
PO-4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO-5	**Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems.
PO-6	**The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment
PO-7	**Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.
PO-8	**Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO-9	**Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO-10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO-11	**Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

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Credit Framework for UG Programme in Civil Engineering (Level 6.0 - B.Tech. In Civil Engineering with Multidisciplinary Minor) - Semester – VII

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
									TA	MST	ESE
1	PCC	R5CE4001T	Research Methodology	2	0	0	2	2	20	30	50
2	PEC	R5SE4101T*	Programme Elective Course – III	3	1	0	4	4	20	30	50
3	PEC	R5SE4102T*	Programme Elective Course – IV	3	1	0	4	4	20	30	50
4	MDM	R5CE4201T*	Multidisciplinary Minor – V	3	1	0	4	4	20	30	50
5	OE	R5CE4301T*	Open Elective – II	3	1	0	4	4	20	30	50
6	VSEC	R5CE4002L	Civil Engineering Software Laboratory	0	0	2	2	1	ISCE: 60		40
7	VSEC	R5SE4001L	Structural Engineering Software Laboratory	0	0	2	2	1	ISCE: 60		40
8	P	R5CE4801P	Project	0	0	8	8	4	ISCE: 60		40
			Total	14	4	12	30	24			

Abbreviations: **T** Theory Course, **L** Laboratory Course, **I** Internship, **P** Project, **TA** Teacher Assessment / Term work Assessment, **MST** Mid Semester Test, **ESE** End Semester Written Examination, **ISCE** In-semester Continuous Evaluation, **PCC** Program Core, **MDM** Multi-Disciplinary Minor **VSEC** Vocational and Skill Enhancement Course, **OE** Open Elective, **VEC** Value Education Course

* Relevant Course Code for Program elective, Open Elective, and Multidisciplinary Minor (Sem V) to be used

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Credit Framework for UG Programme in Civil Engineering (Level 6.0 - B.Tech. In Civil Engineering with Multidisciplinary Minor) - Semester – VIII

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
									TA	MST	ESE
1	OJT	R5CE4701I	Internship					12	ISCE: 60		40
2	HSSM	R5CE4002T	Innovation and Construction Entrepreneurship (Online)	2	0	0	2	2	20	30	50
			Total	2	0	0	2	14			

Abbreviations: **T** Theory Course, **L** Laboratory Course, **I** Internship, **P** Project, **TA** Teacher Assessment / Term work Assessment, **MST** Mid Semester Test, **ESE** End Semester Written Examination, **ISCE** In-semester Continuous Evaluation, **PCC** Program Core, **MDM** Multi-Disciplinary Minor **VSEC** Vocational and Skill Enhancement Course, **OE** Open Elective, **VEC** Value Education Course

*Relevant Course Code for Program elective, Open Elective, and Multidisciplinary Minor (Sem VI) to be used

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Course Codes for Program Electives (PEC)

Sr. No.	Course Code	Program Elective III (Sem VII)	Name of the Program Elective track
1	R5SE4101T	Structural Health Monitoring	Structural Engineering I
2	R5SE4102T	Design of Pre-stressed concrete structures	Structural Engineering II
3	R5CE4101T	Construction Contract Management	Construction Engineering and Management
4	R5SE4103T	Advanced Foundation Engineering	Geotechnical Engineering
5	R5CE4102T	Hydrographic Surveying	Geo Informatics
6	R5CE4103T	Unit Operations and Processes in Environmental Engineering	Environmental Engineering
7	R5CE4104T	Transportation Economics	Transportation Engineering
8	R5CE4105T	Ground Water Engineering	Hydrology & Water Resources Engineering
9	R5CE4106T	Computational Fluid dynamics	Hydraulics

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Course Codes for Program Electives (PEC)

Sr. No.	Course Code	Program Elective IV (Sem VII)	Name of the Program Elective track
1	R5SE4104T	Advanced Design of Concrete and Steel Structures	Structural Engineering I
2	R5SE4105T	Structural Dynamics and Earthquake Engineering	Structural Engineering II
3	R5CE4107T	Rehabilitation of Buildings	Construction Engineering and Management
4	R5SE4106T	Geosynthetic Engineering	Geotechnical Engineering
5	R5CE4108T	Digital Terrain Analysis	Geo Informatics
6	R5CE4109T	Solid and Hazardous Waste Management	Environmental Engineering
7	R5CE4110T	High Speed Rail Engineering	Transportation Engineering
8	R5CE4111T	Water Resources System Planning and Management	Hydrology & Water Resources Engineering
9	R5CE4112T	Design of Hydraulic Structures	Hydraulics

Course Codes for Multi-Disciplinary Minors (MDM)

Sr. No.	Course Code	Name of the MDM Course in Sem V	Name of the MDM
1	R5CE4201T	Management Information System	Innovation and Entrepreneurship
2	R5CE4202T	Appraisal Implementation for Infrastructure Projects	Contract Law, Arbitration, and Valuation
3	R5CE4203T	Climate Change and Adaptation	Sustainable Environment

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Course Codes for Open Elective (OE)

Sr. No.	Course Code	Name of the MDM Course in Sem VII
1	R5CE4301T	Environment Legislation and Management
2	R5CE4302T	Environment, Health and Safety for Engineers

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Semester VII

Semester - VII		PCC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	R5CE4001T	Research Methodology	2-0-0	2	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. To apply the fundamental concepts of research, including its meaning, purpose, types, approaches, and significance. 2. To gain knowledge of sampling techniques and data collection methods. 3. To apply statistical techniques for data analysis and hypothesis testing. 4. To develop comprehensive skills in technical paper and report writing,							

Module	Course Content
1	**Research Methodology: An Introduction** Meaning and purpose of research, Motivation and objectives of research. Types of research - Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Some Other Types of Research. Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done.
2	**Research Process** Research Process: Formulation of research problem, Literature Survey, Objectives of research problem, Hypothesis Development, Research Design, Sample Design, Data Collection (Primary and secondary data), Execution, Data Analysis, Hypothesis Testing, Generalization, and Report Writing. Criteria of Good Research and Problems Encountered by Researchers in India. Types of Research Designs, Basic Principles of Experimental Designs
3	**Sampling Design and Data Collection** Census and Sample surveys, Steps in sample design, Different types of sample designs, Techniques of selecting a random sample design. Primary and secondary data. Collection methods: Observation, Interview, Questionnaire Schedule,

	Pretest, Pilot study.
4	**Hypothesis Testing** Fundamentals and procedure of hypothesis testing, flow diagram for hypothesis testing, Parametric hypothesis testing: Z-Test, T-Test, F-Test, Chi-Square Test, Anova Test: One way Anova and Two-way Anova.
5	**Technical Paper and Report Writing** Basic concepts of paper writing and report writing, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing, Types of Research reports, Methods of presentation of report: Content, Chapter format, Presentation of tables and figures, Referencing, Use and format of appendices- Indexing Editing and evaluating the final draft.
	Reference Books: 1. Research Methodology: R. Panneerselvam, Prentice Hall Publication ,2004 2. Research Methodology: Methods and Techniques by C. R. Kothari New Age International Publishing, second edition 3. Statistical Methods for Research Workers, Fisher R. A. Macmillan Pub Co, 1970 4. Design and Analysis of Experiments, Montgomery D.C. John Wiley, 2001 5. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.

PROGRAM ELECTIVE COURSES - III

Semester - VII		PEC	Structural Engineering 1					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
2	R5SE4101T	Structural Health Monitoring	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Examine the necessity and challenges of Structural Health Monitoring (SHM). 2. Explain various techniques used for damage detection. 3. Apply structural health monitoring techniques.							

Module	Course Contents
1	**Non-Destructive Evaluation** Assessment methods for concrete strength including rebound hammer test, ultrasonic pulse velocity test, penetration resistance, pull-out tests, and core sampling. Chemical evaluation methods such as carbonation, chloride content analysis, and corrosion assessment are also included.
2	**Introduction to Structural Health Monitoring** Overview of factors affecting structural integrity, SHM frameworks, steps involved in monitoring, damage identification methods, and associated challenges. Includes experimental and operational modal analysis.
3	**Methods of Damage Detection** Study of vibration-based damage detection techniques including modal parameters (frequency, shape, damping), curvature and flexibility methods, modal strain energy approach, sensitivity analysis, and baseline-free methods.
4	**Health Monitoring of Building Structures and Prognosis** Topics include numerical modelling, sensor technologies, data acquisition systems, data processing, diagnostic techniques, wireless sensor networks, and rehabilitation methods, Damage Mechanism, Life Prediction Tools, Remaining Useful Life, Using real-time or periodic SHM data to inform decisions on when to repair or replace components, reducing downtime and costs
5	**Health Monitoring of Bridges** Covers measurement parameters, sensor and transducer technologies, and monitoring techniques such as vibration analysis, strain gauge instrumentation, destructive and non-destructive testing, and load testing.
	Text Books: 1. Farrar, C.R. and Worden, K., Structural Health Monitoring: A Machine Learning Perspective, John Wiley & Sons, 2012--2013.

	2. Nagayama, T. and Spencer Jr., B.F., Structural Health Monitoring using Smart Sensors, University of Illinois, 2007. **Reference Books:** 1. Glisic, B. and Inaudi, D., Fibre Optic Methods for Structural Health Monitoring, John Wiley & Sons, 2008. 2. Do, R., Passive and Active Sensing Technologies for Structural Health Monitoring, University of California, San Diego, 2014. 3. Pierre Dersin., Modeling Remaining Useful Life Dynamics in Reliability Engineering, CRC, 2023

Semester - VII		PEC	Structural Engineering II					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
3	R5SE4102T	Design of Pre-stressed concrete structures	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course, students will be able to 1. Implement the principles of pre-stressed concrete for analysis of pre-stressed concrete sections. 2. Analyze pre-stressed concrete sections/members. 3. Design of pre-stressed concrete section/ structural members. .							

Module	Course Contents
1	**Introduction to Pre-stressed Concrete** Basic concept and general principles of prestressed concrete, materials used and their properties, methods, technique of prestressing and system of prestressing, loss of prestress, historical perspective on prestressed concrete, basics of bridge design
2	**Analysis of Prestressed Concrete Section for Flexure** Loading stages and computation of section properties, critical sections under working loads for pretensioned and post-tensioned members, load balancing method of analysis of prestressed concrete beams.
3	**Deflections of Prestressed Concrete Members** Importance of control of deflection, factors influencing deflection, short term and long term deflection. Deflection of simply supported beam
4	**Design of Pre-Stressed Concrete Section for Flexure** General philosophy of design, design approaches in working stress method and limit state method, critical conditions for design, limit state of collapse in flexure, permissible stresses in concrete and steel.
5	**Analysis And Design Of Pre-Stressed Concrete Members For Shear And Torsion** Shear strength calculation under limit state of collapse for both cracked and uncracked in flexure. Analysis of prestressed concrete section subjected to torsion.
6	**Analysis and Design of end zone of Pre-Stressed Concrete Members** Transfer of pre-stress in pre-tensioned members: Pretension transfer bond, transmission length, end zone reinforcement. Anchor zone stresses in post-tensioned members: stress distribution in end block, anchor zone reinforcement.
7	**Design of Prestressed Concrete Members** Design of simply supported pretensioned and posttensioned slabs and beams.

	introduction to application of prestressing to continuous beams and portal frames, linear transformation and concordancy of cables.
8	**Innovative Trends in Prestressed Concrete Construction** Introduction to external pre-stressing, concept of extradosing in PC bridges, pre-stressed concrete earthquake resistance structure
	Text Books: 1. Krishna Raju, Prestressed Concrete, Tata McGraw Hill Publishing Co., 2000 2. G.S.Pandit and S.P.Gupta, Prestressed concrete, CBS Publishers and Distributers Pvt.Ltd, second edition,2014. **Reference Books:** 1. Evans R. H. and Bennett E. W., Prestressed Concrete, Champman and Hall, London, 1958. 2. Lin T. Y., Design of Prestressed Concrete Structures, John Wiley and Sons Inc., 1981. 3. Sinha N. C. and Roy S. K., Fundamentals of Prestressed Concrete, S. Chand and Co., 1998. 4. Rajagopalan N., Prestressed Concrete, Narosa Publications, New Delhi, 2008. 5. FIB Bulletin 51: Structural Concrete – Textbook on behaviour, design and performance, Volume I, November 2009. 6. FIB Bulletin 52: Structural Concrete – Textbook on behaviour, design and performance, Volume II, January 2010. 7. FIB Bulletin 53: Structural Concrete – Textbook on behaviour, design and performance, Volume III, December 2009. **IS codes** : 1. IS: 1343- 2012: Code of Practice for Prestressed Concrete. 2. IRC 112- 2011 Code of Practice for Concrete Road Bridges.

Semester - VII		PEC	Construction Engineering and Management					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
4	R5CE4101T	Construction Contract Management	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. To evaluate legal issues faced by the construction agencies. 2. To analyze trade union problems, workers' problems in view of legal provisions. 3. To analyze the contract conditions and their impact on project execution.							

Module	Course Content
1	**Introduction to Contract** Definition and legal issues in contract, Essential requirement of a contract as per Indian Contract Act 1872, Characteristics of a good contract, Legal enforceability of contract, Breach & termination of contracts.
2	**Forms of Entities and contracts:** Sole Proprietorship Firm, Partnership firm, Private Limited Company, Limited Company – listed and unlisted, Society and Trust. Lump sum contracts, Fixed price contracts, Percentage rate contracts, Cost plus contracts, Target contracts, Design-Build contracts, EPC, MES, FIDIC,PPP.
3	**Bids and Tendering Process** Introduction, Bidding Systems, Electronic Procurement (e-Procurement), Modes of Tendering, Preparing Bid Documents, Publication, Receipt and Opening of Bids, Evaluation of Bids and Award of Work, Execution and Monitoring of Works and Quality Assurance, RA Bill, Design Approvals, General conditions & special conditions, Time Monitoring, Financial Monitoring, Closure of Contract, Subcontracting, Liabilities of Joint Venture. Bid Security and Performance Security, Risk Management
4	**Construction Disputes Resolution** Causes and resolution of disputes, settlement for claims and extra items, arbitration. Comparison Laws-Agreements, Appointment of Arbitrators, Conditions of Arbitrations, Powers and duties of Arbitrator, Enforcement of Award-costs, Arbitration Act old & new.

	Reference Books: 1. Construction Contracting, Clough Richarch, John Wiley & Sons, New York, 1986. 2. Gajaria G.T., "Laws Relating to Building and Engineering Contracts in India ", M.M.Tripathi Private Ltd., Bombay, 1982. 3. Jimmie Hinze, Construction Contracts, McGraw Hill, 2001. 4. Joseph T. Bockrath, Contracts and the Legal Environment for Engineers and Architects, McGraw Hill, 2000.

Semester - VII		PEC	Geotechnical Engineering					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
5	R5SE4103T	Advanced Foundation Engineering	3-1-0=4	4	20	30	50	3

Course Outcomes

After completion of this course, students will be able to,

1. Evaluate compressibility and shear strength of soil.
2. Evaluate the safe allowable bearing capacity of and settlement shallow foundation.
3. Determine load carrying capacity and settlement of single and group piles under downward a lateral load.
4. Illustrate the methods of ground improvement technique for improvement of weak soils.

Module	Course Contents
1	**Consolidation and Shear Strength** One dimensional consolidation, Terzaghi's theory, differential equation, and solution (Optional), Different loading; constant, linear and sinusoidal variation pore pressure variation, pore pressure parameters, shear strength of sand, critical void ratio, dilatancy.
2	**Bearing Capacity of Soils** Shallow foundations, Terzaghi theory: detailed derivation, Various bearing capacity methods to determine net ultimate bearing capacity, factors affecting ultimate. **Bearing capacity**: shape, GWL, eccentricity and compressibility of clay (including critical rigidity Index criteria), settlement analysis for clay and sand, elastic settlement use of Steinbrenner and Fox Theory, Schmertmman's method, primary consolidation. Bearing capacity of foundation on compact and weathered rock. Raft foundation.
3	**Pile Foundation** Pile load test, laterally loaded pile, Separation of end bearing and shaft friction, settlement of single pile and group piles in sand and clay, Based on uniaxial compressive rock, safe load on weathered rock. Laterally loaded pile- subgrade reaction approach, lateral deflection of single pile – free head, partially fixed head, and fixed head pile, p-y curves. Introduction to pile raft. NDT of pile, PDA etc.
4	**Ground Improvement**

	Sand drains and stone columns. Reinforced Earth Wall: Materials and general considerations, Design and Stability or Soil Nailing -Application, components, materials used for nailing.
	Text Books: 1. Terzaghi K. and Peck R. B., Soil Mechanics in Engineering Practice, Wiley and Sons,1996. 2. Holtz, R.D. & Kovacs, W.D., "An introduction to geotechnical engineering", Prentice Hall, 1981. 3. Das B. M. Advanced Soil Mechanics, 4th Ed. C.R.C. Press, 2013. 4. Das B. M., Shallow Foundation- Bearing Capacity & Settlement" Taylor & Francis, 2009 5. Ranjan, Gopal & Rao, A.S.R., "Basic and applied soil mechanics", New Age International Pvt. Ltd., 2004 **Reference Books:** 1. Bowles J. E., Foundation Analysis and Design, McGraw-Hill Book Co, 2001. 2. Shamsher P. and Sharma H., Pile Foundations in Engineering Practice, Wiley and Sons,1990. 3. Purushothama R., Ground Improvement Techniques (HB), Laxmi Publication Pvt Ltd. New Delhi, 2005. 4. Hausmann M. R., Engineering Principles of Ground Modification McGraw-Hill Inc, US, 1990. 6. Murthy V.N.S., Advanced Foundation Engineering, CBD Publishers and Distributors, New Delhi, 2010. **IS Codes :** 1. IS 14593:1998, Design and Construction of Bored Cast-in-Situ Piles. New Delhi, India: BIS, 1998. 2. S 12070:1987, Code of Practice for Design and Construction of Shallow Foundations on Rock. New Delhi, India: BIS, 1987. 3. IS 2911 (Part 1/Sec 2): 2010, Design and Construction of Pile Foundations—Code of Practice, Part 1: Concrete Piles, Section 2: Bored Cast In-situ Concrete Piles. New Delhi, India: BIS, 2010.

Semester - VII		PEC	Geo Informatics					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
6	R5CE4102T	Hydrographic Surveying	3-1-0	4	20	30	50	3
	Course Outcome: After completion, students will be able to: 1. Explain principles of hydrographic surveying and tidal phenomena 2. Apply depth measurement techniques using modern instruments 3. Analyze positional data for underwater mapping 4. Prepare hydrographic charts and bathymetric maps							

Module	Course Content
1	**Introduction and Tides** Definition, scope, and importance of hydrographic surveying. Applications: navigation, harbor design, dredging, coastal engineering. Challenges in hydrographic surveying. Tides: definition, types, and theory, Tide measurement using gauges.
2	**Sounding Methods (Depth Measurement)** Direct methods: sounding rods and lead line, Echo sounding: principles and working, Single beam and multi-beam echo sounders, Corrections in soundings (velocity, draft, tide) , Errors in depth measurement.
3	**Position Fixing Techniques** Shore-based positioning methods (angles and distances) , Three-point problem, Intersection and resection methods, Range and bearing methods, electronic positioning systems: GPS, DGPS, Use of total station in hydrographic surveys
4	**Instruments and Equipment** Echo sounders and sonar systems (side scan sonar) , GPS and DGPS equipment, Current meters , Survey vessels and accessories , Data acquisition and logging systems.
5	**Data Processing and Applications** Hydrographic data collection and recording, Data reduction and corrections , plotting of soundings , Contouring and preparation of bathymetric maps , Hydrographic chart preparation, Use of GIS in hydrographic surveying.

	Reference Books: 1. Reeve, W. G. (1981). *Hydrographic Surveying*. London: Institution of Civil Engineers / Thomas Telford Publishing. 2. Punmia, B. C., Jain, A. K., & Jain, A. K. (2016). *Surveying and Levelling, Vol. I & II*. New Delhi: Laxmi Publications 3. Ghilani, C. D., & Wolf, P. R. (2021). *Elementary Surveying: An Introduction to Geomatics*. Upper Saddle River, NJ: Pearson Education .

Semester - VII		PEC	Environmental Engineering					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
7	R5CE4103T	Unit Operations and Processes in Environmental Engineering	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Classify and select appropriate process units for water and wastewater treatment based on influent characteristics and treatment objectives. 2. Compare and analyze pollutant removal mechanisms in physicochemical and biological treatment processes. 3. Design water and wastewater treatment systems by integrating technical, environmental, economic, and social considerations. 4. Evaluate emerging and advanced treatment technologies for wastewater treatment and water reuse based on performance, feasibility, and operational criteria.							

Module	Course Content
1	**Introduction** Need of preliminary, primary, secondary, tertiary, advanced treatments, Unit operations and processes: definition; examples.
2	**Unit Operations** Screens: classification, design consideration, screen characteristics and quantities. Flow equalization: Description, application and design consideration. Mixing and flocculation: rapid mixing & flocculation, different types, design consideration. Gravity Separation: Discrete & flocculent particle settling. Flotation: Description, applications, design consideration. Aeration: Oxygen transfer, types of aeration systems. Filtration: Slow sand filter and rapid sand filter.

3	**Chemical Unit Processes** Role of chemical unit processes in treatment,coagulation for removal of turbidity and colour; chemical precipitation for removal of heavy metals, phosphorous removal; chemical oxidation for removal of BOD/COD, chemical neutralization.
4	**Biological Unit Processes** Oxidation of organic matter, synthesis, auto oxidation, aerobic and anaerobic processes, biological removal of nitrogen and phosphorous, biological removal of toxic organic compounds
	Text Books: 1. T. D. Reynolds and P. D. Richards, Unit Operations and Processes in Environmental Engineering, PWS publishing Company, 2nd edition, 1996. (ISBN: 0534948847) 2. Robert Noyes, Unit Operations in Environmental Engineering, 2nd Edition, William Andrew Publishing, 1994. (ISBN: 978-0815513438) 3. M. N. Rao and A. K. Datta, Wastewater Treatment: Rational Methods of Design and Industrial Practices, Oxford and IBH Publishing, 3rd edition, 2007. (ISBN: 9788120417120) 4. Manual on Water Supply and Treatment, Ministry of Works & Housing, New Delhi, 1993. 5. Manual on Wastewater Treatment, Ministry of Works & Housing, New Delhi, 2013
	Reference Books: 1. S. J. Arceivala and S.R.Asolekar, Wastewater Treatment for pollution control & reuse, , Tata McGraw Hill Pvt Ltd, New Delhi, 3rd edition, 2008. (ISBN:ISBN: 9780070620995) 2. S. R. Qasim, Wastewater Treatment Plants: Planning, Design and Operation, 2nd Edition, Taylor and Francis Publishing, CRC Press 1998. (ISBN:9781566766883) 3. Metcalf and Eddy, Wastewater Engineering Treatment and Reuse, Tata McGraw Hill Education, 5th edition, 2017. (ISBN: 9780070495395/0070495394)

Semester - VII		PEC	Transportation Engineering					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
8	R5CE4104T	Transportation Economics	3-1-0	4	20	30	50	3
	Course Outcome: After completion of the course, students will be able to: 1. Estimate road user cost and time value of money. 2. Perform economic analysis of a transportation project. 3. Evaluate alternate transportation project proposals. 4. Carry out life-cycle cost analysis of transportation projects							

Module	Course Contents
1	**Introduction to Transportation Economics** Basic components of transport economics, review of engineering economics, elements of engineering economics, microeconomics, principles of economic analysis, Depreciation and Inflation, Consumer and Social Surplus
2	**Transport Costs and Benefits** Fixed and variable cost, Cost of improvement, Maintenance cost, Cost estimating methods, Pavement cost analysis, Direct benefits: reduced vehicle operation costs, Value of travel time savings, Value of increased comfort and convenience, Cost of accident reduction, and reduction in maintenance costs.
3	**Economic Valuation Techniques** Generation and screening of project alternatives - Different methods of economic analysis: - Discounting and Non discounting criteria methods, NPV, IRR, Benefit/Cost analysis. Application of economic theory in traffic assignment problem: Break-even analysis, Road User Cost Study (RUCS) models for costs and benefits.
4	**Transportation Project Appraisal and Evaluation** Feasibility and evaluation, cost, impacts and performance levels, evaluation of alternatives, Analysis techniques: Cost-benefit analysis, social and financial benefits, prioritization of projects, multi-criteria decision assessment. Life Cycle Cost Analysis (LCCA) of different pavement types. Role of Highway Development and Maintenance (HDM) in feasibility studies.

	Text Books: 1. J L Riggs, D D Bedworth and S U Randhawa, Engineering Economics, Tata McGraw Hill, Delhi, 2009. 2. S Mishra, Engineering Economics and Costing, 2nd Edition, Prentice Hall of India, New Delhi, 2010. 3. IRC: SP: 30-2009, Manual on Economic Evaluation of Highway Projects inIndia, Indian Roads Congress, New Delhi, 1993. 4. P K Sarkar and V Maitri, Economics in Highway and Transportation Planning, Standard Publisher, New Delhi,2010. 5. C G Swaminathan and L R Kadiyali, Road User Cost Study in India, Central Road Research Institute, New Delhi,1983.

Semester - VII		PEC	Hydrology and Water Resources Engineering					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
9	R5CE4105T	Ground Water Engineering	3-1-0	4	20	30	50	3
	Course Outcome: After completion of the course, students will be able to: 1. Apply basics of fluid flow through porous media. 2. Estimate aquifers characteristics using pumping tests. 3. Predict ground water variation using modeling techniques. 4. Plan ground water basins, prevent sea water intrusion, and control pollution in aquifers.							

Module	Course Contents
1	**Introduction and Ground Water** Occurrence of ground water, geological formations as aquifers; types of aquifers, ground water movement, Darcy's law, permeability and its measurement, tracing of ground water movement, fundamental equations for steady and unsteady ground water flow, flow nets.
2	**Well Hydraulics** Steady and unsteady flow in confined, semi-confined and unconfined aquifers, radial flow, superposition; multiple well system. Different methods of well construction; construction of well casings and screens, natural and artificial gravel packed wells. Safe yields, estimation, pumping and recuperation tests, Infiltration galleries.
3	**Artificial Recharge of Ground Water** Ground-water replenishment, Artificial recharge of ground water, different methods, merits, demerits , selection criteria for various methods, cone of depression
4	**Groundwater Modeling Techniques and Salt Water Intrusion** Porous media models, analog models, electric analog models, digital computer models, Concept of salt water intrusion, interface and its location, control of intrusion.
5	**Transport of Pollutants in Ground Water** Pollutant transport, Plume Transport, source identification, tracer methods
	Text Books:

	1. David Keith Todd, Groundwater Hydrology, John Wiley Publishers, 2004. 2. Jacob and Bear, Hydraulics of Groundwater, McGraw Hill, 1997. 3. K N Mutreja, Applied Hydrology, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1990. 4. Raghunath, Groundwater & Well Hydraulics, Wiley Eastern Ltd, New Delhi, 1992. 5. P Vijay Singh, Elementary Hydrology, Prentice Hall, INDIA,1992.

Semester - VII		PEC	Hydraulics					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
10	R5CE4106T	Computational Fluid Dynamics	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Analyzr the basic governing equations and concepts of CFD and their applications in engineering problems. 2. Analyze knowledge of the set up a CFD problem by identifying the fluid domain, boundary conditions, and appropriate grid generation techniques. 3. Apply various discretization techniques (FDM, FVM, FEM) to solve partial differential equations (PDEs) governing fluid flow and heat transfer. 4. Utilize CFD tool for grid generation, simulation, and post-processing of fluid flow problems and interpret CFD simulation results.							

Module	Course Content
1	**Introduction to CFD and Governing Equations** Review of basic fluid flow and the Governing equations, Navier-Stokes equations: significance, Structure of organism CFD, overview of commercial CFD software and tool, Role of CFD in Engineering applications.
2	**Problem Definition and Grid Generation** Problem identification in CFD with boundary Condition. Define - fluid domain with engineering problem fluid flow and heat transfer and create grid types of method: structured, unstructured, hybrid, grid quality parameters. Hands-on tutorial on grid using commercial software package.
3	**Discretization Methods and Numerical Techniques** Techniques for solution of PDEs – Fundamental of various discretization techniques in one-dimension discretization in two-dimensional diffusion type problems, Understanding the SIMPLE algorithm and flow field calculations, Hands-on tutorial laminar flow through circular tube using commercial software tool.
4	**Turbulence Models and Applications** Important features of turbulent flows, Necessity of turbulence modeling, Application of turbulence models in CFD simulations, Hands-on tutorial turbulence flow using commercial software tool.
5	**Implementation and Flow Prediction**

	Implementation of CFD steps using commercial software, Flow prediction: Contour plots, vector plots, and streamlines, Post-processing techniques and result interpretation, Validation and verification of CFD results.
	Suggested Textbooks: 1. S V Patankar, Numerical Heat Transfer and Fluid Flow, McGraw Hill, NY, (2005). 2. John Anderson, Computational Fluid Dynamics, McGraw-Hill Publication, 1st edition (February 1, 1995). 3. Versteeg, H.K., and Malalasekara, W, "An Introduction to Computational Fluid Dynamics", The Finite Volume Method, 2007.

PROGRAM ELECTIVE COURSES -IV

Semester - VII		PEC	Structural Engineering 1					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
11	R5SE4104T	Advance Design of Concrete and Introduction to Cold Form Section	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Analyze and design of RCC and steel section 2. Apply the principles, procedures and current codes of practice for the design of various reinforced, pre-stressed concrete structures, cold form section 3. Conceive and design steel and pre stressed concrete bridges along with their substructures and foundation							

Module	Course Contents
1	**Design Methods** Introduction to the concept of limit design of structural components and yield line analysis of slabs and its application to the prevailing codes of practice. Study of limit states of collapse and serviceability. Application of these concepts to design of structural components.
2	**Design of silos and Bunker** Study of behaviour of silos and bunker. Analysis and design of Silos and Bunker
3	**Design of Retaining Structures** Review of Retaining Wall and Water Tank Design principles. Design of Silos and Bunkers. Design and detailing of Retaining Walls of Basements of High Rise Structures.
4	**Design of Superstructure of Segmental Bridges** Types of bridges. Technique of construction of bridges. Principles of analysis, design and detailing of segmental bridges. Study of prevailing code provisions and their application. Analysis and design of the superstructure using software tools available.
5	**Introduction To Cold Form Section** Effective width and direct strength method of design for cold form steel section. Design of column, beam.

	Textbooks: 1. Park R. and Paulay T., Reinforced Concrete Structures, John Wiley & Sons, 1975. Purushothaman P., Reinforced Concrete Structural Elements, Tata McGraw-Hill, 1984. Kong and Evans, Reinforce and Prestressed Concrete Structures, ELBS, 1995. 2. Nilson A. H., Design of Concrete Structures, McGraw-Hill, 1997. 3. Pillai S. U. and Menon D., Reinforced Concrete Design, Tata McGraw-Hill, 2003. Varghese P. C., Advanced Reinforced Concrete Design, Prentice-Hall of India, 2005.IS: 456-2000, Plain and Reinforced Concrete Code of Practice. 4. Rajagopalan N., Prestressed Concrete, Narosa Publications, New Delhi, 2008.IS: 1343- 1980: Code of Practice for Prestressed Concrete. 5. Taylor F. W., Thomson S. E. and Smulski E., Reinforced Concrete Bridges, John Wiley & Sons, New York, 1955. **Reference Books:** 1. Raina V. K., Concrete Bridge Practice, Tata McGraw Hill Publishing Co., New Delhi – 1991. 2. Conference Proceedings, Advances and Innovations in Bridge Engineering, IIT, Madras and Indian Institute of Bridge Engi Tamilnadu, Allied Publisher, New Delhi, 1999. 3. Johnson V. D., Essentials of Bridge Engineering, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2006. 4. Krishna Raju N., Design of Bridges, Fourth edition, Oxford & IBM Publishing Co., Bombay, 2009. **Relevant IS Codes:** 1. IRC 112- 2011 Code of Practice for Concrete Road Bridges. 2. IS 811:2004 Specification For Cold formed light gauge structural Steel sections 3. IS 801: 1975 Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members In General Building Construction 4. BS 5950-5: 1998 Code of practice for design of cold formed thin gauge sections 5. IS: 4995 (Part I) – 2008 Criteria For Design Of Reinforced Concrete Bins For The Storage Of Granular And Powdery Materials Part I General Requirements And Assessment Of Bin Loads 6. IS: 4995 (Part II) – 2003 Criteria For Design Of Reinforced Concrete B-Ins For Storage Of Granular And Powdery Materials Part II Design Criteria 7. IRC: 6-2000 Standard Specifications and Code of Practice for Road Bridges, The RoadCongress. 8. IS: 875(Part3)- 2007: Wind Loads on Buildings and Structures.

Semester - VII		PEC	Structural Engineering II					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
12	R5SE4105T	Structural Dynamics and Earthquake Engineering	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Describe the causes and effects of earthquakes. 2. Apply the principles of structural dynamics to analyze systems under dynamic loads. 3. Apply the principles of structural dynamics to structural design structures							

Module	Course Contents
1	**Fundamental Of Structural Dynamics** Definitions of basic problems in dynamics, static v/s dynamic loads, different types of dynamic loads, undammed vibration of SDOF system, natural frequency and periods of vibration, damping in structure, response to periodic loads. Direct determination of frequencies and mode shapes, orthogonality principle, approximate methods for determination of frequencies and mode shapes, modal error of, forced vibration of MDOF system, modal analysis, applications to multi-storeyed rigid frames subject to lateral dynamic loads
2	**Seismological Background** Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic rebound theory of earthquake, Richter scale, measurement of ground motion, seismogram
3	**Characterization Of Ground Motion** Earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudovelocity, pseudo-acceleration response spectra, peak structural response from response spectrum, response spectrum characteristics. Introduction to concepts of probabilistic earthquake response. Introduction to Transient Analysis and Floor Response Spectra for design of secondary systems like piping, equipment, in-structure water pools etc
4	**Deterministic Earthquake Response** Types of earthquake excitation, lumped SDOF elastic systems, translational excitation, umped MDOF elastic systems, translational excitation time history analysis, multistoried buildings with symmetric plans, multistoried buildings with un-symmetric plans, torsional response of symmetric plan building, distributed-parameter elastic systems, translational excitation, combining maximum modal

	responses using mean square response of a single mode, SRSS and CQCC combination of modal responses
5	**I. S. code method of seismic analysis and design** Seismic co-efficient method and its limitation, response spectrum method, I. S. code provision for seismic analysis of buildings. Seismic design considerations, allowable ductility demand, ductility capacity, reinforcement detailing for members and joints
6	**Review of damages during past earthquakes and remedial measures** Case studies of damage and remedial action taken for past earthquakes in India and abroad
7	**Introduction to new IS 1893 Part 1: 2025**
	Text Books: 1. Duggal S. K., Earthquake Resistant Design of Structures, Oxford University Press, 2007. 2. Agarwal P. and Shrikhande M., Earthquake Resistant Design of Structures, Prentice Hall of India, 2006 3. Chopra A. K., Dynamics of Structures, Pearson Education, 2001. **Reference Books:** 1. Biggs J. M., Introduction to Structural Dynamics, McGraw Hill, 1964. 2. Paulay T. and Priestly M. N. J., Aseismic Design of Reinforced Concrete and Masonry Buildings, John Wiley and Sons, 1991. 3. Taranath B. S., Structural Analysis and Design of Tall Buildings, McGraw Hill Book Company, New York, 1999. 4. Paz M., Structural Dynamics: Theory and Computation, Kluwer Academic Publication, 2004. 5. 6..Karmer S. L., Geotechnical Earthquake Engineering, Prentice Hall PTR, 1996. 6. Roy. D. and Rao G., Elements of Structural Dynamics: A New Perspective, John Wiley and Son, 2012. **IS Codes :** 1. IS 1893- Part 1 (2016), General Provisions and Buildings, Criteria for Earthquake Resistant Design of Structures, Published by Bureau of Indian Standard Manak Bhavan, New Delhi. 2. IS 1893- Part 4 (2002), Industrial Structures Including Stack- Like Structures, Criteria for Earthquake Resistant Design of Structures, Published by Bureau of Indian Standard Manak, Bhavan, New Delhi 3. IS 1893- Part 1 (2025), General Provisions and Buildings, Criteria for Earthquake Resistant Design of Structures, Published by Bureau of Indian Standard Manak Bhavan, New Delhi.

Semester - VII		PEC	Construction Engineering and Management					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
13	R5CE107T	Rehabilitation of Buildings	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. To identify various types of distress in concrete structures.. 2. To identify the effects due to climate, temperature, chemicals, wear and erosion on structures. 3. Justify appropriate materials and techniques for repairs and rehabilitation							

Module	Course Content
1	**Buildings** Post occupancy evaluation of buildings, deformation and common defects in buildings.
2	**Concrete behaviour** Embedded metal corrosion. Disintegration mechanisms, moisture effect, exposure to aggressive chemicals, thermal effects, load effects, faulty workmanship. Models for deterioration.
3	**Basics of cracking problems** Structural & Non-structural cracks, crack type, important characteristics & possible reasons.
4	**Condition survey** Objective, preliminary inspection, visual inspection, Field & laboratory testing. Non-destructive evaluation: Rebound Hammer, U.P.V, Infra-red Thermography, carbonation test, Half-cell potential, cover meter. Structural appraisal and structural monitoring: Principles of appraisal, data collection, types of deficiencies/disorders.
5	**Various materials for repair** Properties, Cement, aggregate, wire mesh, admixtures, bonding agents, corrosion protection, repair mortar, protective coating, and polymer modified mortar.
6	**Various techniques of rehabilitation** Repairs to corrosion infected members, damaged water proofing, junction of beam, column, wall, jacketing, fibre wrapping technique Different types of shoring, under pinning.
7	**Maintenance of buildings** Routine maintenance, Preventive measures, Remedial maintenance.
	Text Books:

	1. K. Saxena, Repairs, Rehabilitation & Restoration of structures, Anuvi Chemicals Ltd. 2. J. J. Shah, Point of View – Repair, Rehabilitation and Waterproofing of Structures-Some View,Published in April 1998 issue of The Indian Concrete Journal, Mumbai.
	Reference Books: 1. P. K. Guha, Maintenance and Repairs of Buildings, New Central Book Agency (P) Ltd., Kolkata, 2nd edition, 2015. (ISBN: 9788173810732) 2. M. S. Shetty, Concrete Technology (Theory and Practice), S. Chand & Co Ltd., 2008. (ISBN: 9788121900034) 3. P. C. Varghese, Maintenance, Repair & Rehabilitation & Minor Works of Buildings, PHI Learning Private Limited, Delhi,2004. (ISBN: 9788120349452) 4. J. Bhattacharjee, Concrete Structures- Repair, Rehabilitation and Retrofitting, CBS Publishers & Distributors Pvt Ltd, New Delhi, 2017. (ISBN: 9789385915901)

Semester - VII		PEC	Geotechnical Engineering					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
14	R5SE4106T	Geosynthetic Engineering	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Select geosynthetics for the intended purpose. 2. Evaluate the properties of geosynthetics. 3. Design geosynthetics for the intended purpose. 4. Design geocomposite systems to solve contemporary geotechnical and landfill problems.							

Module	Course Contents
1	**Introduction** Introduction to geosynthetics. Functions of geosynthetics such as reinforcement, separation, filtration, drainage, and barrier functions.
2	**Physical, mechanical, hydraulic & durability properties** Physical properties such as mass per unit area, thickness, and specific gravity. Hydraulic properties including apparent opening size, permittivity, and transmissivity. Mechanical properties including uniaxial tensile strength, burst strength, puncture strength, and soil–geosynthetic friction tests. Durability aspects such as abrasion resistance and ultraviolet resistance.
3	**Testing methods for geosynthetics** Techniques for testing different index properties and strength properties; determination of apparent opening size; in-plane and cross-plane permeability tests; assessment of construction-induced damage; extrapolation of long-term strength properties from short-term tests.
4	**Drainage and filtration applications of geosynthetics** Different filtration requirements; filtration in different types of soils; criteria for selection of geotextiles; estimation of water flow in retaining walls, pavements, and similar structures; selection of appropriate geosynthetics
5	**Reinforced soil slope** Basal reinforcement for construction on soft clay soils; construction of steep slopes using reinforcement layers on competent soils; slope stability analysis methods such as planar wedge method, bi-linear wedge method, and circular slip methods; erosion control on slopes using geosynthetics.

6	**Pavement application** Pavement design using Giroud–Noiray approach; reflection cracking and its control using geosynthetics; application of geosynthetics in construction of heavy container yards and railway lines.
7	**Construction of landfills using geosynthetics** Components of modern landfills; leachate collection techniques; application of geonets and geotextiles for drainage in landfills; use of geomembranes and geosynthetic clay liners (GCL) as barrier systems.
	Textbooks: 1 G. V. Rao and G. V. Suryanarayana Raju, *Engineering with Geosynthetics*, Tata McGraw Hill, New Delhi, 1990 (ISBN: 007460323X / 9780074603239). 2 M. Robert Koerner, *Designing with Geosynthetics*, Prentice Hall, New Jersey, U.S., 2012 (ISBN: 9781465345240 / 1465345248). 3 S. K. Shukla, *Handbook of Geosynthetic Engineering: Geosynthetics and Their Applications* (ISBN: 9780727741752 / 0727741756). **Reference Books:** 1 M. Robert Koerner, *Construction and Geotechnical Methods in Foundation Engineering*, McGraw Hill, New York, 1985 (ISBN: 0070352453 / 9780070352452). 2 R. A. Jewell, *Soil Reinforcement with Geotextiles*, CIRIA, London, 1996 (ISBN: 0860174255 / 9780860174257). 3 N. W. M. John, *Geotextiles*, John Blackie and Sons Ltd., London, 1987 (ISBN: 0216919959 / 9780216919952). 4 *Proceedings of the Conference on Polymer and Reinforcement*, Thomas Telford Co., London, 1984 (ISBN: 0727702424 / 9780727702425).

Semester - VII		PEC	Geo Informatics					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
15	R5CE4108T	Digital Terrain Analysis	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Interpret images for terrain data analysis. 2. Carry out spatial analysis of landforms with non-spatial data. 3. Generate thematic map for decision making on Civil Engineering project activities.							

Module	Course Content
1	**Terrain Attributes and Their Significance** Topographic Relief, Slope and Aspects, Land use, Land cover, Drainage-density, Pattern texture etc, Geology, lithology and Structure of soil and their properties
2	**Sources of Terrain Data** Field Surveys, Topographic and other maps, Arial Photographs, satellite Images
3	**Digital Terrain Modeling and Analysis** Sources, Representation and interpolation Electro Magnetic Interference and Vibration Measurement
4	**Products of Digital Elevation Models(DEMs) and their use** Profiles, Sections, Contours, Slope, Shape and 3-D Views, Watersheds, River and its tributaries extraction
5	**Applications of DEMs** Alignment Selection, Earth Works, Water resources potential, soil erosion potential etc.
6	**Meteorological / Hydrological data** Rainfall, Humidity, Sunshine, Wind speed etc, Flow and sediment measurement, underwater survey.
7	**Data Base Development** Principles, Programming and utilization
8	**Compilation of Thematic Maps** Visual Interpretation and Digital analysis, Digitization and Rasterisation, information analysis systems: Principles and applications.
	Text Books:

	1. C.P. Lo and Albert K. W. Yeung, Concept and Techniques of Geographic Information Systems, Prentice Hall of India, New Delhi, 2nd edition, 2016. (ISBN: 9789332581883, 9332581886) 2. Kang-tsung Chang, Introduction to Geographic Information Systems, Tata McGraw Hill Education, 8th edition, 2015. (ISBN: 978-0078095139/0078095131) **Reference Books:** 1. P.A. Burrough, Principles of Geographical Information Systems for Land Resources Assessment, Oxford science Publications, U.K, 1986. (ISBN: 978-0198545927 /0198545924)

Semester - VII		PEC	Environmental Engineering					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
16	R5CE4109T	Solid and Hazardous waste Management	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Use the principles of solid & hazardous waste management. 2. Design & optimize techniques for solid & hazardous waste management. 3. Acquire knowledge on specialized solid & hazardous waste treatment. 4. Analyze policies and legal implications of solid and hazardous wastes							

Module	Course Content
1	**Solid Wastes -** sources, types: Muncipal solid waste, Industrial solid waste, e-waste, construction and demoliation waste, composition, physical, chemical, and biological properties of solid wastes
2	**Functional Elements of Solid waste management-** generation, collection, handling, storage, processing, transportation
3	**Disposal of Solid waste -** materials separation and processing, thermal conversion, biological and chemical conversion, recycling and reuse of municipal solid wastes, land filling, composting, gas generation, closure of landfills, design of landfills.
4	**Industrial solid waste composition,** biodegradable, non-biodegradable, hazardous, toxic solid wastes, methods of detoxification, disposal on land
5	**Hazardous wastes -** origin, sources and types of hazardous and infectious wastes in municipal solid wastes, quality parameters.
6	**Treatment and disposal methods of Hazardous waste -** physicochemical and biological. Stabilization and solidification, thermal methods, land disposal, site remediation.
7	**Legal aspects of municipal and hazardous solid waste collection**, conveyance, treatment and disposal.
	Text Books:

	1. G. Tchobanoglous, H. Theisen and S. A. Vigil, Integrated Solid Waste Management, McGraw 2. Hill Education (Indian Edition), 1st edition, 2014. (ISBN: 9789339205249/9339205243) 3. M. D. LaGrega, P. L. Buckingham and J. C. Evans, Hazardous Waste Management, Waveland Press Inc,, 2nd edition, 2010.(ISBN: 978-1577666936/1577666933) 4. A.D. Bhide and B. B. Sundaresan,Solid waste Management in Developing Countries, National Environmental Engineering Research Institute (NEERI) Nagpur. 5. T V Ramachandra, Management of Municipal Solid Waste, The Energy and Resources Institute, TERI, 2009. (ISBN:9788179931875) **Reference Books:** 1. Tchobanoglous, Theissen and Vigil,Integrated Solid Waste Management, McGraw Hill Book Co. 2. G. Tchobanoglous, H. Theisen and R Eliassen, Solid wastes - Engineering Principles and Management Issues, Mcgraw-Hill Book Company, 1st edition, 1977. (ISBN: 9780070632356) 3. D. J. Hagerty, J. L. Pavoni and J. E. Heer (Jr.), Solid Waste Management, Van Nostrand ReinholdCo., New York, 1973. (ISBN: 0442230265) 4. J. L. Pavoni, Handbook of Solid Waste Disposal: Materials and Energy Recovery, Van Nostrand Reinhold environmental engineering series, Krieger Pub Co., 1st edition, 1975. (ISBN: 978-0442230272/0442230273) 5. P. A. Reinhardt and J. G. Gordon, Infectious and Medical Waste Management, CRC Press, 1st edition, 1990. (ISBN:9780873711586/0873711580)

Semester - VII		PEC	Transportation Engineering					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
17	R5CE4110T	High Speed Rail Engineering	3-1-0	4	20	30	50	3
	Course Outcome: After completion of the course, students will be able to: 1. Design geometric alignments for high speed rail corridors. 2. Analyze advanced track structures and ballastless track systems. 3. Evaluate aerodynamic impacts on high speed rolling stock. 4. Assess modern signaling and safety systems for high speed networks.							

Module	Course Contents
1	**Introduction and Planning of HSR Systems** Evolution and history of high speed rail globally (Shinkansen, TGV, ICE), Definitions and classifications of HSR, Comparison between conventional railways and high speed railways, Feasibility studies, alignment planning, and route selection criteria., The Indian context: The Mumbai Ahmedabad High Speed Rail (MAHSR) project and future corridors.
2	**Geometric Design for High Speeds** Principles of dynamic vehicle track interaction, Horizontal alignment: Radius of curve, cant (superelevation), cant deficiency, and uncompensated radial acceleration, Transition curves: Types, length calculations, and jerk limits, Vertical alignment: Gradients, vertical curves, and passenger comfort criteria, Clearances and moving dimensions for high speed trains.
3	**Advanced Track Structures and Geotechnology** Limitations of conventional ballasted tracks at high speeds (ballast flying phenomenon), Ballastless track systems (Slab tracks): Types, design principles, and construction methodologies, Rail metallurgy, continuously welded rails (CWR), and rail fastening systems for high stiffness.
4	**Rolling Stock, Aerodynamics, and Traction** Bogie design, suspension systems, and articulation, Train aerodynamics: Micro pressure waves in tunnels, crosswind stability, and aerodynamic drag, Pantograph and catenary wire interaction at high velocities, Traction power supply systems (25kV AC) and regenerative braking.
5	**Signaling, Safety, and Environmental Impact** Advanced signaling systems: European Train Control System (ETCS) Level 2 and Level 3, Automatic Train Control (ATC), Noise and vibration generation,

	propagation, and mitigation strategies (sound barriers, floating slab tracks), Disaster management and earthquake early warning systems.
	Text Books: 1. Railway Transportation Systems: Design, Construction and Operation" by Christos N. Pyrgidis. 2. High-Speed Rail Planning, Policy, and Engineering" by Terry L. Koglin 3. Train Aerodynamics: Fundamentals and Applications" by Chris Baker, et al. .

Semester - VII		PEC	Hydrology and Water Resources Engineering					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
18	R5CE4111T	Water Resources System Planning and Management	3-1-0	4	20	30	50	3
	Course Outcome: After completion of the course, students will be able to: 1. Apply economic principles, legal frameworks, and uncertainty analysis to evaluate water resource projects. 2. Formulate system analysis models and optimization techniques for water allocation and parameter identification. 3. Develop sustainable management strategies for groundwater use, water quality, and flood mitigation. 4. Plan and operate multi-purpose reservoir systems using decision support systems and GIS tools.							

Module	Course Contents
1	**Introduction to Water Management** Introduction: history of water resources development, water resources of India, problems and perspectives, conceptual framework. Economics of Water resources planning: benefit cost analysis of water resources projects, water pricing and water allocation, principles of planning and financing water resources projects
2	**Water Law** Water Law: riparian rights, groundwater ownership, prior appropriation, permit systems, acquisition and use of rights. Uncertainty concepts in Water Resources Planning: methods for uncertainty analysis and applications
3	**Ground Water Management** Ground Water Management: inverse problem of parameter identification, management models embedding and response matrix approaches, optimal experimental design for parameter identification, conjunctive use of surface and ground water systems.
4	**Optimal planning and Operation** Optimal planning and operation of single and multiple reservoirs, planning and development of multipurpose projects, decision support systems for water resources management, sustainable development of water resources. Coastal zone management. Use of GIS in Water Resources Planning.
5	**Water Quality Management**

	Water Quality Management in rivers, streams, and other water bodies. Flood mitigation and management: structural and non-structural measures, optimal flood mitigation plan, flood damage estimation. Planning, design and management of irrigation, hydropower and flood control.
	Text Books: 1. David Keith Todd, Groundwater Hydrology, John Wiley Publishers, 2004. 2. Jacob and Bear, Hydraulics of Groundwater, McGraw Hill, 1997. 3. K N Mutreja, Applied Hydrology, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1990. 4. Raghunath, Groundwater & Well Hydraulics, Wiley Eastern Ltd, New Delhi, 1992. 5. P Vijay Singh, Elementary Hydrology, Prentice Hall, INDIA,1992.

Semester - VII		PEC	Hydraulics					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
19	R5CE4112T	Design of Hydraulic Structures	3-1-0	4	20	30	50	3
	Course Outcome: After completion of the course, students will be able to: 1. Design and analyze the stability of gravity dams. 2. Perform seepage and stability analysis for embankment dams. 3. Design appropriate spillways and dam outlet works. 4. Develop physical hydraulic models using dimensional analysis.							

Module	Course Contents
1	**Introduction to Hydraulic Structures** Introduction: Hydraulic structures for water resources projects. Various Hydraulic Structures, their need, basic design considerations.
2	**Embankment Dams** Embankment Dams: Types, design considerations, seepage analysis and control, stability analysis, construction techniques.
3	**Gravity Dams** Gravity Dams: Forces acting on failure of a gravity dam, stress analysis, elementary profile, design of gravity dam, other functional features of a gravity dam.
4	**Dam Outlet Works** Dam Outlet Works: Types of outlet structures, ogee spillway, chute spillway, siphon spillway, side channel spillway, Labyrinth and Pianokey weir.
5	**Hydraulic Modeling** Hydraulic Modeling: Basic principles, dimensional analysis, modeling free-surface flows, design of physical models.
	Text Books: 1. Peterka, A.J, “Hydraulic Design of Stilling Basins and Energy Dissipators”, USBR Engineering Monographs No. 25”. 1984 2. "Design of Small Dams", Third Edition, Water Resources Technical Publication – US Bureau of Reclamation. 1987

	3. Singh, B., and Varshney, R.S., "Embankment Dam and Engineering", Nem Chand and Brothers. 2004 4. Chanson, H., “The Hydraulics of Open Channel Flow : An Introduction”, Elsevier Scientific Publications. 2004 5. Novak, P. and Nalluri, C., “Hydraulic Structures”, Edition 4, Taylor & Francis. 2007

Multidisciplinary Minor - Innovation and Entrepreneurship

Semester - VII		Multi Disciplinary Minor	Innovation and Entrepreneurship					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
20	R5CE4201T	Management Information System	3-1-0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Analyze the fundamentals of MIS and identify key components 2. Explore data management systems and concepts in knowledge management systems 3. Examine the role and functionalities of enterprise systems in business operations 4. Analyse IT strategies and E-commerce applications in business operations 5. Develop knowledge of emerging technologies and ethical issues							

Module	Course Contents
1	**Introduction to Management Information Systems** Introduction to Management Information systems :Types of MIS, Capabilities, Complements, CCR Framework; Role of manager with respect to IT in an organization
2	**Data and Knowledge Mangement** Database management systems, Data Warehousing, Big Data, Foundations of business intelligence, BI for data analysis and presentation, Decision Support Systems, Learning Management Systems, Executive Information Systems
3	**Strategic Enterprise Systems - ERP, SCM, CRM, SRM.** Strategic Enterprise Systems - Enterprise Resource Planning (ERP) systems, Supply Chain Management (SCM) systems, Customer Relationship Management (CRM) systems
4	**E-commerce and IT Strategy** Mobile and E-commerce – B2C, B2B and e-procurement, C2C and mobile commerce, Web 2.0 and 3.0, IT Strategy and Balanced Scorecard
5	**Operational Support Systems** Operational Support Systems - Manufacturing Systems, Sales and Marketing Systems, HRIS, Finance and Accounting Systems
6	**Emerging Technologies**

	Emerging Technologies – Cloud computing, Big Data Technologies, Internet of Things, Bring Your Own Device (BYoD,) Virtual Reality, Augmented Reality, Blockchain, Artificial Inelligence
7	**Ethical and Social Issues in MIS** Information Security, Threat to IS , Security Controls, Social , Ethical MIS
	Recommended Reading 1. Kenneth C. Laudon & Jane P. Laudon. "Management Information Systems". Pearson Publishing. 2. Abraham Silberschatz, Henry F. Korth, & S. Sudarshan. "Database System Concepts". 7th edition McGraw Hill 3. Robson. W. Robson. Strategic Management and Information Systems: An Integrated Approach (2nd Edition), Financial Times, 1997. 4. Prasad L.M., Prasad Usha. (2023)" Management Information Systems" Sultan Chand & Sons Publishing 5. Kelly Rainer, Brad Prince, Management Information Systems, Wiley

Multidisciplinary Minor – Contract Law, Arbitration and Valuation

Semester - VII		Multi Disciplinary Minor-5	Contract Law, Arbitration, and Valuation					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
21	R5CE4202T	Appraisal Implementation for Infrastructure Projects	3- 1- 0	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Explain infrastructure projects and their lifecycle. 2. Apply project appraisal techniques. 3. Use project management tools and software. 4. Evaluate financial viability and PPP models.							

Module	Course Contents
1	**Introduction to Infrastructure Projects** Definition and importance of infrastructure projects, Types of infrastructure projects (e.g., transportation, energy, water), Overview of the project lifecycle: polices and planning, feasibility, project selection and approval, construction, operation and maintenance, project evaluation.
2	**Project Appraisal Techniques** Method of Project Appraisal: Economic analysis, Financial analysis, Market analysis, Technical analysis, Managerial competence, Ecological analysis.
3	**Tools And Techniques for Project Management** Tools And Techniques for Project Management. Project selection techniques (a) Cost-benefit analysis and (b) Risk and sensitivity analysis. Project execution planning techniques. Project monitoring and progressing techniques (a) Progress measurement technique (PROMPT) (b) Performance monitoring technique (PERMIT) and (c) Updating, reviewing and reporting technique (URT). Project cost and productivity control techniques (a) Productivity budgeting techniques (b) Value engineering (VE)
4	**Financial Analysis and Funding** Market and Demand Analysis: Information required for market and demand

	analysis , Secondary sources of information, Market survey , Demand forecasting, Uncertainties in demand forecasting. Financial feasibility and economic viability, Sources of financing (public, private, PPP). Budgeting and financial planning, Investment appraisal techniques (NPV, IRR, payback period)
5	**Appraisal of PPP Projects** Definition of PPPs, Roles and Responsibilities of the Parties to a PPP, PPP Structure, Principles of PPP Project Appraisal, Mechanism of Appraisal: Feasibility Assessment, Economic Viability, Risk & Reward Balanced, Post Appraisal Process.
6	**Investment Appraisal** Importance of investment appraisal, investment appraisal /capital budgeting process: planning, analysis, selection , implementation and review. Techniques for Investment Appraisal: Non discounting criteria & Discounting Criteria.
7	**Case Studies and Best Practices** Analysis of successful infrastructure projects, Lessons learned and best practices, Group projects and presentations
	Recommended Reading **1.** Reed B. J, Coates, S., Parry Jones S et al. (2007) Infrastructure for all, WEDC, Loughborough University. **2.** Reference Guide for PPP Project Appraisal, Infrastructure Finance Secretariat, Ministry of Finance, Government of India (2023). **Textbooks** **1.** Prasanna Chandra, (2023), *Projects: Planning, Analysis, Selection, Financing, Implementation and Review,* McGraw Hill Education (India) Pvt. Ltd. **2.** Alvin S. Goodman & Makarand Hastak (2015),*Infrastructure Planning Handbook: Planning, Engineering, and Economics,* McGraw Hill

Multidisciplinary Minor – Sustainable Environment

Semester - VII		Multi Disciplinary Minor	Sustainable Environment					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
22	R5CE4203T	Climate Change and Adaptation.	3-1-0	4	20	30	50	3
	Course Outcome: After completion of the course, students will be able to: 1. Explain the structure and composition of the atmosphere and evaluate air quality using standard indices and emission estimation techniques. 2. Analyze the influence of meteorological parameters on air pollutant dispersion and apply appropriate models to estimate pollutant concentrations. 3. Evaluate climate change using historical data, identify trends, and assess its impacts on environmental and socio-economic systems. 4. Apply carbon footprinting and carbon cycle concepts to quantify emissions and assess mitigation options. 5. Assess climate change mitigation and adaptation strategies using policy frameworks and decision-making tools, and develop practical solutions for real-world problems.						

Module	Course Contents
1	**Atmospheric Systems, Air Quality Metrics, and Emission Estimation** Structure and composition of the atmosphere; ambient air quality standards and indices (AQI); Classification of pollutants ($PM_{2.5}$, PM_{10}, NOx, SO_2, O_3); primary vs secondary formation pathways; Emission sources (natural/anthropogenic) and emission factors; Preparation of a basic emission inventory for transport/area/point sources; AQI computation and interpretation using real datasets (e.g., Indian city data); Introduction to source apportionment concepts.
2	**Meteorology and Air Pollution Dispersion Modeling** Atmospheric stability, lapse rate, inversions, mixing height; Wind systems (geostrophic/gradient), wind profiles, and wind rose analysis; Planetary Boundary Layer and implications for pollutant dispersion; Gaussian plume model: assumptions, formulation, and applications; Estimation of ground-level concentrations under varying meteorological conditions; Interpretation of pollution episodes using meteorological data

3	**Climate Change** Climate vs weather; Earth's energy balance and greenhouse effect; Radiative forcing and role of key greenhouse gases; Analysis of long-term datasets (temperature, precipitation, CO_2) for trend detection; Variability vs change; identification of extremes (heatwaves, intense rainfall); Quantification of impacts on health, water resources, agriculture, and infrastructure; Introduction to risk and vulnerability assessment
4	**Carbon Cycle, Footprinting, and Climate Modeling** Global carbon cycle: reservoirs, fluxes, and feedbacks; Estimation of carbon emissions and sinks (forests, oceans); Carbon footprinting methodologies for products, processes, and institutions; Life Cycle Assessment (LCA) fundamentals; Scenario-based analysis using simplified climate projections (IPCC pathways); Evaluation of mitigation options through emission reduction potential.
5	**Climate Policy, Mitigation–Adaptation Strategies, and Decision Analysis** Evolution and structure of international climate frameworks: UNFCCC, Kyoto Protocol, Paris Agreement; National and urban climate action plans (India-focused); Carbon neutrality and net-zero pathways; Scope 1, 2, 3 emissions accounting; Economic and policy tools: carbon pricing, cost–benefit and cost-effectiveness analysis; Design and evaluation of mitigation and adaptation strategies for sectors (urban, water, infrastructure
6	**Mini Project – Climate Change Assessment and Adaptation Planning** Problem definition (campus/city/sector such as transport, buildings, water); Data collection (air quality, emissions, climate variables); Emission inventory and carbon footprint estimation; Trend analysis and identification of climate risks; Scenario development (business-as-usual vs mitigation/adaptation options); Strategy formulation for emission reduction and climate resilience; Preparation of a technical report and presentation
	Text Books: 1. "Air pollution" by Henry C Perkins - McGraw Hill Publications 2. "Air Pollution" by Wark and Warner 3. Climate and Eco-systems, David Schimel, Princeton University Press, 2013 4. Climate Crisis: An Introductory Guide to Climate Change; David Archer & Stefan Rahmstorf ; Cambridge University Press; 2001 5. Global Warming and Climate Change; Grover Velma.I; Science Publishers; 2008 6. UNFCCC (2008). Compendium on Methods and Tools to Evaluate Impacts of, and Vulnerability and Adaptation to, Climate Change 7. Atmospheric Chemistry and Physics: from Air Pollution to Climate Change, John Wiley, New York, 1998

OPEN ELECTIVE -II

Semester - VII		Open Elective						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
23	R5CE4301T	Environment Legislation and Management	3-1-0	4	20	30	50	3
	Course Outcome: After completion of the course, students will be able to: 1. To elucidate the application of Environmental Management 2. To demonstrate concepts of sustainability for environmental management 3. To analyze the need of environmental legislation.To illustrate the application of National Environmental Protection Acts							

Module	Course Contents
1	**Introduction** Definition of Environmental Management, Principles of Environmental Management, Nature, Scope and Components of Environmental Management, Policies and Legal Aspect of Environ- mental Management
2	**Environmental Impact Assessment (EIA)** Overview of Environmental Impact Assessment (EIA), Need and Importance, Steps involved, Methods of EIA, Public Participation and Communication, Preparation and Review of Environ- mental Impact Assessment Report, Life Cycle Assessment as Environmental Management Tool, Environmental Audit, Components of Audit, Preparation of Audit Reports
3	**Environmental Policy Analysis** Environmental Policy Analysis- Macro level and Micro level, Methods of Policy Analysis, steps involved, Environmental Management Plan (EMP), Components of EMP, Preparation of EMP, Case Study
4	**Organization for Environmental Management** Organization for Environmental Management, Organizational Design, Institutionalization of Environmental management in India, Ministry of Environment and Forest, Central Pollution Control Boards, State Pollution Control Boards, Local Bodies, their scopes, Organizational and Functional issues, Related Issues in Environmental Management.
5	**Environmental Legislation** Environmental Legislation -their need, historical background, national and international acts; Genesis of environmental acts – general procedure followed in

	changing a bill into an act; im- plementation of an act using judiciary, executive and legislative powers and their limitations. Environmental protection agency, air act, water act, water and sewerage Board's Factory act, Municipal acts, acts dealing with hazardous and infections wastes. Preventive and reactive strat- egies for environmental pollution control, sustainable development. ISO: 14000 – its need, procedure to be followed to obtain ISO: 14000 certification, implications of ISO.
	Text Books: 1. Pollution législation – A.K. Mhaskar, M/s. Media Enviro, Pune 2. Environmental Audit – An overview, A. K. Mhaskar – M/s. Media Enviro, Pune. 3. Matter Hazardous Laws Explained. A. K. Mhaskar M/s. Media Enviro, Pune 4. Environmental impact assessment Larry W Canter McGraw Hill International Edition, New York 1996. 5. Environmental Impact Assessment, Lauren David P., Willy Interscience, New Jersey editions. 6. Primes on 'Environmental Management', Prof. P. Khanna, Multitech publications Co. New Delhi 2001. 7. Assessment and analysais of Environmental management, Shukla S. S., Shrivastva P. R. 1992, com- monwealth publishers New Delhi 2003

OPEN ELECTIVE -II

Semester - VII		Open Elective						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
24	R5CE4302T	Environment, Health and Safety for Engineers	3-1-0	4	20	30	50	3
	Course Outcome: After completion of the course, students will be able to: 1. Identify and analyze environmental, health, and safety (EHS) hazards in engineering systems and workplaces. 2. Explain and evaluate the principles, causes, and consequences of occupational health and safety issues. 3. Assess risks using appropriate tools and techniques, and design preventive and control measures to reduce workplace accidents. 4. Interpret and apply safety standards, hazard communication systems, and warning signs in industrial environments. 5. Develop strategies for improving workplace safety performance, including risk mitigation, emergency preparedness, and incident prevention.						

Module	Course Contents
1	**Safety and Health Management** Safety and Health Management: Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety. Safety Psychology, Safety information system, Ergonomics - Introduction, Definition, Objectives, Advantages. Ergonomics Hazards - Musculoskeletal Disorders and Cumula- tive Trauma Disorders. iii. Importance of Industrial safety.
2	**Radiation and Industrial Hazards** Radiation and Industrial Hazards: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement, disposal of radioactive waste, Control of radiation, Indian Standards. ii. Different air pollutants in industries, Effect of different gases and particulate matter, acid fumes, smoke, fog on human health, Industrial Hygiene & Health Unit

3	**Electrical Hazards and Hazards in Construction Industry** Electrical Hazards and Hazards in Construction Industry: Safe limits of amperages, voltages, distance from lines, etc., Joints and connections, Overload and Short circuit protection, Earthing standards and earth fault protection , Protection against voltage fluctuations, Effects of shock on human body Hazards
4	**Fire and other Hazards** Fire and other Hazards: General causes and classification of fire, Detection of fire, extinguishing methods, firefighting installations with and without water. Machine guards and its types, automation. High pressure hazards, safety, emptying, inspecting, repairing, hydraulic and non-destructive testing, hazards and control in mines
5	**Safe use of machines and tools** Safe use of machines and tools: Safety in the use of: Grinding, CNC's computer numeric control, Shearing, Bending, Milling, Boring, Shaping Safe use of hand tools. Plant design and Housekeeping: Plant layout, design and safe distance, Ventilation and heat stress, Significance of ventilation, Natural ventilation, Mechanical ventilation Air conditioning , National Building code part VIII and Building service,
6	**Accident prevention techniques** Principles of accidents prevention: Definition: Incident, accident, injury, dangerous occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistakes, etc. Accident Prevention : Theories of accident occurrences, Principles of accident prevention, Accident and Financial implications, Hazard identification and analysis.
	Text Books: 1. The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai 2. Grimaldi and Simonds , Safety Management, AITBS Publishers , New Delhi (2001) 3. Industrial Safety –National Safety Council of India ISHET.

VSEC- Civil Engineering Software

Semester - VII		VSEC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
25	R5CE4002L	Civil Engineering Software Laboratory	0-0-2	1	ISCE:60		40	3
	Course Outcome: After completion of course students will be able to 1. Apply Construction Cloud to manage, share, and collaborate on construction project data effectively 2. Apply software to model a simple water supply network and interpret basic hydraulic and transient flow behavior 3. Apply sewer modeling software to design and analyze a gravity sewer system 4. Prepare work flow for digital twin technology 5. Apply transportation engineering software to model and analyze basic road systems.							

Experiment No.	Course Contents
1.	Introduction to digital construction project management platforms for project planning, document management, collaboration, RFIs, and issue tracking..
2.	Hydraulic modelling and analysis of water distribution networks using appropriate engineering software.
3.	Hydraulic modelling and design of sewer networks using suitable wastewater network analysis software.
4.	Fundamentals of Digital Twin technology, data integration, visualization, and applications in civil infrastructure.
5.	Modelling and analysis of road geometry, alignment, and transportation infrastructure using suitable transportation engineering software.
6.	Development of Building Information Models (BIM), preparation of working drawings, and interdisciplinary coordination using BIM software.
7.	Project planning, scheduling, resource allocation, and monitoring using project management software.
8.	4D construction planning and simulation using digital construction planning tools.

	Reference Books: 1. User manuals and documentation of digital construction management, BIM, hydraulic modelling, transportation engineering, and Digital Twin software. 2. Project Management Institute. (2021). *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* (7th ed.). 3. Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2018). *BIM Handbook: A Guide to Building Information Modeling* (3rd ed.). Wiley. 4. QGIS Development Team. (2011). *QGIS User Guide*.

Semester - VII		VSEC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
26	R5SE4001L	Structural Engineering Software Laboratory	0-0-2=2	1	ISCE: 60		40	3
	Course Outcome: After completion of course students will be able to 1. Analysis and Design of Reinforced Concrete Structure 2. Analysis and Design of Steel Structure 3. Analysis and Design of Foundation and Slopes							

Experiment No.	Course Contents
	Perform any 10 out of the 12 below experiments
1.	Analysis & Design determinate structures using software.
2.	Analysis & Design fixed & continuous beam using software.
3.	Analysis & Design determinate plane frame using software.
4.	Analysis & Design of space frames subjected to DL & LL.
5.	Analysis & Design of residential building subjected to loads as per IS 456 using software
6.	Analysis & Design of Roof Trusses.
7.	Design and detailing of built up steel beam.
8.	Developing a design Programme for foundation using software
9.	Detailing of RCC beam and RCC slab using software
10.	Detailing of Steel built up compression member using software.
11.	To evaluate the bearing capacity of foundation using software.
12	Analysis and Design of Reinforced Concrete Retaining Walls Using Software.
	Text Books: 1. Bansal R.K., *Strength of Materials*, Laxmi Publications, 5th edition, 2010. (ISBN: 9788131808146) 2. S. S. Bhavikatti, *Structural Analysis*, Vikas Publishing House Pvt. Ltd., 4th edition, 2013. (ISBN: 9789325967212) 3. B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, *Reinforced Concrete Structures*, Laxmi Publications, 10th edition, 2009. (ISBN: 9788131808146)

	4. S. K. Duggal, *Limit State Design of Steel Structures*, Tata McGraw Hill Education, 2nd edition, 2010. (ISBN: 9780070681163) **Reference Books:** 1. Hibbeler R.C., *Structural Analysis*, Pearson Education, 9th edition, 2012. (ISBN: 9780134610672) **IS Codes:** 1. IS 1893- Part 1 (2016), General Provisions and Buildings, Criteria for Earthquake Resistant Design of Structures, Published by Bureau of Indian Standard Manak Bhavan, New Delhi. 2. IS 1893- Part 4 (2002), Industrial Structures Including Stack- Like Structures, Criteria for Earthquake Resistant Design of Structures, Published by Bureau of Indian Standard Manak, Bhavan, New Delhi 3. IS 1893- Part 1 (2025), General Provisions and Buildings, Criteria for Earthquake Resistant Design of Structures, Published by Bureau of Indian Standard Manak Bhavan, New Delhi. 4. Bureau of Indian Standards, *IS 456: Plain and Reinforced Concrete – Code of Practice*, BIS, New Delhi, Latest revision.

Project

Semester - VII		P						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
27	R5CE4801P	Project	0-0-8	4	ISCE: 60		40	3
	Course Outcome: After completion, students will be able to: 1. Review available knowledge with reference to the specific problem 2. Formulate the methodology for the problem, collect relevant data, and create a systematic approach to arrive at a solution. 3. Execute/analyze and interpret the data and find solution 4. Prepare technical report and present.							

Module	Course Content
1	**Problem definition and data collection** Every student has to work on a one-semester project in the last year under the guidance of a Guide allotted by the department. A project can also be done in a group of not more than four students. In case of a group project, role of every individual should be clearly defined. The project may be related to theoretical analysis, fabrication of a model and experimental work, etc. Through the project, students have to exhibit both the analytical and practical skills. The evaluation shall be done at the end of seventh semester. Students are expected to define the problem and its scope, complete literature survey and finalize methodology for data collection. They are also expected to give critical comments, necessity of work, scheme of experiments etc.
2	**Result finding and Final Report** At the time of evaluation, substantial data collection and analysis work should be completed. In the final stage student has to submit a report in standard

	format prescribed by the institute. The report must contain introduction of the research, literature review, materials and methods, results and discussion, conclusions and bibliography.

Semester VIII

Semester - VIII		OJT						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	R5CE4701I	Industry Internship	0-0-0	12	ISCE:60		40	3
	Course Outcome: After completion, students will be able to: 1. Relate engineering knowledge and civil engineering works 2. Use Standard practices in civil engineering projects 3. Write technical report 4. Work as an individual and team							

Module	Course Content
1	Student will undergo internship for one semester for one semester in any of the Civil engineering firms to have an exposure to practical aspects of structural engineering, geotechnical engineering, environmental engineering, transportation engineering, water resources engineering, construction engineering and management etc. The student is expected to learn the following: 1) Office/ Site Documents, working Drawings, Tendering and Billing Process 2) Preparation and Monitoring Bar chart, Activity Network diagram to understood activities of ongoing construction sites 3) Construction Site Safety and Health practices, Quality Parameters of construction materials and Techniques 4) On hand practice on Construction / Project management software's and other equivalent activity.
2	Student will submit a report and give presentation based on internship. The internship report shall cover the following: Introduction, Brief History of the Organization, Summary of the Project

	Assignment, Technical and practical information gained during the summer training period, Planning, Designing, check lists, Quality practices, safety measures, record keeping etc. (This must constitute the major part of the report), Conclusion and Recommendations, Photo gallery, References, Appendices

Semester - VII		HSSM						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
2	R5CE4002T	Innovation and Construction Entrepreneurship (Online)	2-0-0	2	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Evaluate economics of construction environment 2. Prepare and submit bids and tenders 3. Analyze policies regarding planning & organizing resources. 4. Identify the risks and define strategy to manage risk and safety.							

Module	Course Contents
1	**Indian construction industry and environment for entrepreneurship in India** Projects in construction and the unique features, Role of a Project Manager, Project Stakeholders and governance. Overview of entrepreneurship in India, historical perspectives and evolution of Indian start up ecosystem, Key sectors and industries driving entrepreneurship in India. Case studies of famous entrepreneurs and their impact, social norms and their impact on entrepreneurial activities. Types of entities, Sole Proprietorship firm, Trust, Society, Articles of Association and Memorandum of Association
2	**Construction enterprise organization** Forms of business organization, structure of construction organization, organization structures for managing projects, management levels, organizational influences on construction project management.
3	**Construction economics** Economic decision making, time value of money, evaluating alternatives, Investment criteria: Net present value, benefit cost ratio, internal rate of return, urgency, payback period, accounting rate of return, working capital needs, financing for working capital, Funds: cash flow, sources of funds.
4	**Construction contract** Bidding process, General contract conditions (CPWD and FIDIC), sub-contracting, models of PPP, Estimation of costs and bidding strategies, bid preparation, bidding models, Tendering, Modes of Tendering, Tender Notice.
5	**Claims management** Claims identification, claim quantification, claim prevention, claim resolution, contract dispute, disruption analysis and project closure, and settlement method. Arbitration and its detailed procedure

Text Books:

1. P.C.Tripathi and P. N. Reddy, Principles of Management, Tata McGraw-Hill Education, 4th edition, 2010. (ISBN: 9780070220881/0070220883)
2. K. K. Chitkara, Construction Project Management- Planning, Scheduling and Controlling, Tata McGraw Hill Education, 2nd edition, 2010. (ISBN: 9780070680753/ 0070680752).
3. P. M. Charantimath ,Entrepreneurship Development and Small Business Enterprise, Dorling Kindersley (India) Pvt. Ltd., Licensees of Pearson Education, 2006.(ISBN: 9788177582604)
4. U. K. Shrivastava, Construction Planning and Management, Galgotia Publications Pvt. Ltd, New Delhi, 2013. (ISBN: 9788175152465, 817515246X

Reference Books:

1. R.L.Peurifoy, C. J. Schexnayder, A. Shapira and R. Schmitt, Construction Planning, Equipment, and Methods (Civil Engineering), McGraw-Hill Education, 8th edition, 2010. (ISBN: 9780073401126/0073401129)
2. H. Koontz and H. Weihrich, Essentials of Management: An International, Innovation, and Leadership perspective, McGraw Hill Education, New Delhi ,9th edition, 2012. (ISBN:9781259005121/1259005127)
3. F. Harris, R. McCaffer with Francis Edum-Fotwe, Modern Construction Management, Wiley- Blackwell, 7th edition, 2013.. (ISBN:ISBN: 9780470672174)
4. M. W.Martin and R. Schinzinger, Ethics in Engineering, McGraw-Hill Education, 4th edition.2004. (ISBN: 978-0072831153/0072831154)
5. C. Hendrickson and T. Au, Project Management for Construction - Fundamentals Concepts for Owners, Engineers, Architects and Builders, Prentice Hall, Pittsburgh, 2000.
6. J. L. Riggs, D. D. Bedworth and S. U. Randhawa, Engineerng Economics, Tata McGraw hill.4 edition, 1996..(ISBN: 9780079122483/0079122485)